European Commission DG TREN

Preparatory studies for Eco-design Requirements of EuPs

Simple Digital TV Converters
(Simple Set Top Boxes)

Final Report

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Preface

This Preparatory study on “Simple Set Top Boxes” is in support of the directive 2005/32/EC of the European parliament and of the Council of 6 July 2005.

The main objective of the directive is to establish a framework for the setting of eco-design requirements for energy-using products (EuP).

The methodology developed by VHK for the European Commission (MEEUP2005) is followed.

The report is based on discussions, presentations and documentation from core stakeholders and is made available, for comment and input, to all stakeholders, through the web-site:

www.ecostb.org

and

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All comments and input will be shown to and discussed with the European Commission. They may be shown in the final report without identification of the source unless that is specifically agreed.

SIMPLE DIGITAL TV CONVERTORS (SIMPLE SET TOP BOXES)

CONTENT

1 Task 1: Definition

1.1 Introduction

Less than two decades ago Television or TV was synonymous with analogue terrestrial television. As new distribution channels developed, such as satellite TV and cable TV the demand for adaptors to link the new broadcasting technology to the existing TV and VCR equipment started to grow. These converters were the first set-top-boxes to be added to the existing TV-set by the consumer. Set-top-boxes opened the door to new broadcasting systems for the consumer (and to higher electricity bills as well)

The simple set top boxes (STBs) considered in this study are an intermediate technology to keep existing analogue television equipment functioning in the transition to digital broadcasting. These products will be required for a limited period only. Current schedules[1] predict an end to analogue terrestrial television broadcasting in Europe by 2015, with South-east Europe regions likely to be the last to switchover. At that stage the number of simple STBs required to convert analogue television equipment will start a dramatic decline and products already installed will probably be disposed of when the associated analogue television equipment is replaced. The set top box will still exist as a product genre to provide high functionality to basic television equipment as new broadcasting and home networking technologies emerge.

This study focuses on terrestrial (DVB-T), Satellite- (DVB-S), Cable- (DVB-C). The primary purpose of these simple STBs is to allow legacy analogue television equipment to receive basic and additional digital broadcasting services in the transition to full digital television broadcasting. Digital television tuner/demodulators that require an add- on processing platform, such as those in USB stick form factor for personal computers are not part of this study.

[1]) Source EBU and DigiTag

1.2 Product Category and Performance Assessment

The generic product in this preparatory study is the set-top-box. A general definition of set-top-boxes is:

A STB is an appliance for the reception, decoding, processing and local networking of digital broadcasting and related services.

Additional functionalities implemented in a STB could be:

• Conditional Access (CA)

• Networking: examples of networking functions are VoIP and the provision of principal signals for other products

• Recording

• Interfacing

• Return channel (allowing unique user interaction with broadcast content)

• Picture and sound processing.

1.2.1 Existing Product definitions

What is a *simple STB* and what specifications for simple STBs are used? [2]

To define these products, trade categorisations, voluntary and mandatory initiatives, and relevant International test standards were studied. For the definition of simple STBs for this study the following sources are considered the most appropriate: the EU Code of Conduct, the California Energy Commission (CEC), the US Environmental Protection Agency (EPA) for Energy Star and Standards Australia.

The simple STB definition of the *EU Code of Conduct*:

"Simple digital TV converter"
A stand alone device, using an integral or dedicated external power supply, for the reception of (free) Standard Definition (SD) or High Definition (HD) digital broadcasting services and their conversion to analogue RF and/or line signals.
The following components/features are included in the power allowance targets but do not constitute a minimum specification (i.e. they may not be present in the device):

- Tuner/demodulator:
  - Cable version: Single cable tuner/demodulator
  - Terrestrial version: Single RF tuner /demodulator, active antenna powering
  - Satellite version: Single satellite tuner / demodulator, single LNB feed.
- Single MPEG Decoder (SD or HD as appropriate)
- Analogue Composite and Component video outputs
- One Analogue Composite and Component video input
- Stereo analogue audio out
- Stereo analogue audio in
- Support for Off-air Software Upgrade
- Electronic Programme Guide (EPG)
- Operating system support for Interactive Services (e.g. MHEG /MHP/OpenTV etc.)
- no return path
- Timer control facilities
- Auto standby

[2]) H.P. Siderius: Categorising STBs - simple or complex? IEA International Workshop Paris 2007

The simple STB definition of the *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.

The simple STB definition of the US Environmental Protection Agency for *Energy Star:*

"Digital television adapter" (DTA) A DTA receives terrestrial, (over the air) digital signals and converts them to an analogue output suitable for analogue TVs. It does not provide ad digital signal output. The DTA category does not include converters that work with satellite or cable digital signals, nor does it cover devices with multi-functionality such as a DVD player with digital to analogue conversion capability

The simple STB definition of the Standards Australia:

DTV STB–Free-to-Air (FTA) A commercially available electronic product with a primary purpose to receive and decode FTA terrestrial digital television broadcast signals, for use by a video display device or a recording device. The standard distinguishes Standard definition (SD) decoding (the ability to decode video transport streams that are MPEG 2 MP@ML) and High definition (HD) decoding (the ability to decode video transport streams that are MPEG 2 MP@HL).

From these definitions there is no clear identification of a simple STB. What the definitions have in common is that the box should be able to receive digital (television) broadcasting signals (services). The CEC, Energy Star and Australian definitions are restricted to terrestrial broadcasting, and the Australian definition does not indicate that the received signals have to be converted to analogue signals. Both the EU and Australian definitions (explicitly) allow for more functions than the conversion to analogue signals. Furthermore, the EU Code of Conduct and the Australian Standard also provide definitions for (more) complex STB. In this context the Energy Star definition extends criteria to the reception, though not the output streaming, of high definition broadcast information.

If the definitions and specifications of the simple boxes and the complex are considered, the following conclusions can be drawn. The decisive factor as to whether a box is a complex box or a simple box seems to be the involvement of a service provider: that is a vertical market subscription television service. A complex box comes with Conditional Access (CA) support and the service provider is able to manipulate the functional characteristics of the box. Therefore an initial definition of a simple box appears to be "one that has no conditional access" set of functions that is service provider controlled.

Risk assessment of the definitions

For a workable definition, a risk assessment of the proposal is needed: e.g. is the definition **robust** on the one hand, and **flexible** enough on the other hand, to be used in regulation? The proposition is that a definition is robust if it cannot be (easily) qualified in the context of the wording of that definition. A definition is flexible if it allows future trends in functionality to be included.

For ***robustness*** the qualification is, can manufacturers modify the STB design in such way that:

a) the STB does not meet the accepted product definition on which eco-design criteria is based and therefore need not comply with related regulatory parameters
b) the modification costs are less than the costs needed to meet the regulatory criteria.

A closed definition runs high risks of being circumvented by products that have some functionality that is not included in the definition. The CEC definition is closed (by the words 'sole purpose') but in this case the risks are minimized because the same definition will be used in a subsidy program and therefore it is not likely that condition b) will be fulfilled.

But also a more open definition, e.g. the EU Code of Conduct, can be avoided by jumping to the next category of functionality, the complex STB. An allowance table makes this more difficult, because adding functionalities from the allowance table does not bring the STB outside the "simple" definition; it merely allows some extra power consumption for the added functionalities. Furthermore, in both the Code of Conduct and the Australian Standard the (total) extra power consumption allowed is limited. So, whatever functionality from the allowance table is added, the total consumption of the STB in standby active mode should not be higher than e.g. 15 W.

However, in principle the naming *simple* suggest that complex boxes exist, which – by definition – will be outside the scope of regulation for simple boxes.

The ***flexibility*** refers to the question; is the definition flexible enough to cope with functional and technological trends? What is complex today can be simple tomorrow and in general, regulation cannot be changed overnight and should be stable for a longer period, so that it can be used as a design guidance for STB developers and manufacturers.

What are the trends expected for *simple* STB? In the near future, to take full advantage of the usable lifetime of TVs and video recorders with analogue tuners, simple STB will be used to enable the reception of digital TV broadcasting. However, it is likely that recording functions will be included and it may have a return channel for interactive applications. The return channel would not necessarily be Internet based; it can be PSTN or GPRS. An important trend in the simple STB will be the move to High Definition television broadcast reception and output. Significant stocks of standard definition simple STB are likely to be replaced by High Definition versions in the switchover period.

As the broadcasting infrastructure in each European member state switches from analogue to digital, TVs will have integrated tuners and decoders to receive these broadcasts. The simple STB, marketed with the prime function of ***converting*** digital broadcast signals to analogue signals will rapidly become obsolete. STBs that provide many functional features to enhance the basic TV functions will still have a significant market, but as argued later, may usually fall under the definition of a complex STB.

The ***conclusion*** regarding the risk assessment on current definitions of simple STBs is, that these are not robust or flexible enough to be used in product categorisation for, say, regulation. Either they are closed and therefore easy to circumvent or they draw an arbitrary line between simple and other (complex) STBs, which can become obsolete with technology and market changes.

So how to solve this problem? In the next section a possible solution is provided.

The basic rules for a viable definition are:

1. The STB manufacturer is the addressee of regulation because potential regulation targets tangible products.
2. Regulation should only target those issues that are in the control of addressee (in this case the STB manufacturer).
3. Regulation is to be based on the functionality that is (actually) provided to the end user

Potential consequences of these rules are

1. The functionality that is specified by another party (other than the manufacturer) defines the boundary between simple (regulated) and complex (not yet regulated) STBs. For example: Conditional Access (CA) and always-on (AO) functions.
2. The principle of efficient design and efficient components should be supported by means of an allowance table for added functions.
3. Potential (but not used) functions should not qualify.

The availability of conditional access (CA) and STB functions that need to be *always on* (AO) are important differentiators between simple and complex STB.

So the *definition of simple STBs* is given by the absence of any conditional access (CA) module. *Simple STBs just offer no CA*. Throughout this study the products that meet this definition of "Simple Digital TV Converters" are referred to as "Simple STBs".

There is one problem remaining with this definition: There are - by this definition - simple STBs including hard disks for time shift purposes and there are simple STBs with integrated DVD-player coming to the market. To solve this problem simple STBs with additional integrated and not removable storage components as hard disks are simple STBs with an additional feature, i.e. with extra allowances for these features. Combo products integrating exchangeable media, as DVD-players or others, are not covered by the definition of Simple STBs.

Definition of a "Simple" STB:

1. A "Simple" STB is a STB with no CA (Conditional Access) function. If the product is sold with a CA interface, this should not be active if the product is to comply with the definition. A Common Interface connector is an acceptable feature of a "Simple" STB provided that it is not equipped with an active CA functional block.
2. Time shift and recording functions based on integrated hard disc, flash card or solid-state memory are acceptable added functions of a "Simple" STB.
3. A "Simple" STB offers no recording function based on removable media in a standard library format (DVD, VHS tape etc.). Such devices may, in future, be categorised as Complex STBs or more logically as a separate product genre – the Digital Television Recorder.
4. HD (High Definition) broadcast signal reception converted to HD (or SD- Standard Definition)) video output streaming is an acceptable added function of a "Simple" STB.

1.2.2 Scope of the study

The targets of the study are simple STBs, i.e. STBs without conditional access (CA) as explained in the definition above.

The main criterion under review in the study is the energy efficiency of simple STBs. In detail this is influenced by:

- Efficient design and efficient components (to meet power consumption targets) defined by
  - A basic configuration with a basic power consumption target.
  - An allowance table with additional functions for which additional power consumption is defined. (Functions not covered by the allowance table are assumed to be covered by the basic configuration - unless they involve CA and/or AO functions)
- Power management (the STB is always in the lowest power consumption mode for the required functionality) Power management can encompass:
  - Timer control facilities
  - Automatic standby feature

    (Where CA and AO functions are present they should be inhibited or switched off by power management in a product supplied as a simple STB)

Only DVB Satellite, Cable and Terrestrial broadcast reception and conversion STB platforms fall within the remit of the study (not IPTV platforms).

1.2.3 Technical parameters

The technical parameters of simple STBs are shown in the figure below. Figure 1.1 shows a simplified generic block diagram of a typical set top box. Some of the opportunities for power management of these circuit blocks in relation to operational and standby states are reviewed.

The blocks consuming the majority of the power are

- the main processor,
- MPEG decoder (often part of the main processor)
- RF front-end and the
- power supply / power distribution itself.

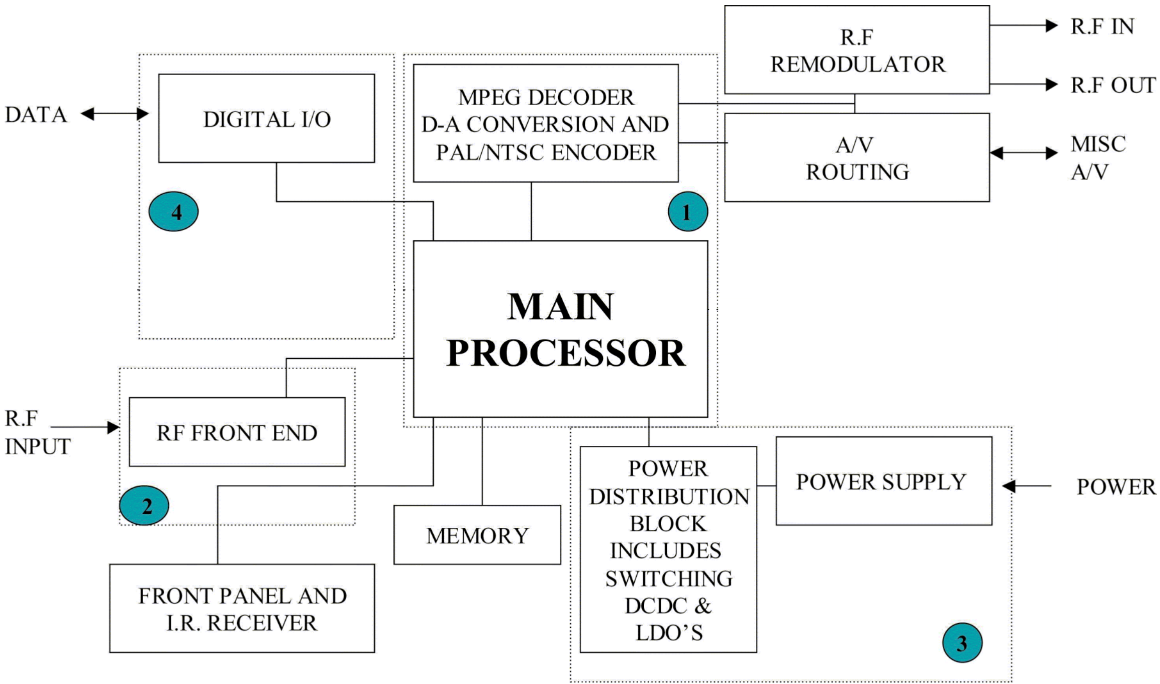

Figure 1.1: Simplified generic Block Diagram of a typical Set Top Box

Block 1: MPEG Decoder Main Processor

In standby no TV picture is required so the MPEG decoder (along with D-A conversion and composite video encoding) can be disabled to reduce power consumption. Increasingly, this MPEG decoding to output streaming (digital and analogue output interfaces) is an integral part of the main processor. The choice of software architecture can also have significant impact on energy consumption.

Block 2: RF front-end

In the Standby-passive state the RF front-end can be disabled or put into sleep mode. This also applies to two or more RF Tuners in STBs with integral storage. Where the STB automatically comes out of standby to download data it may be possible to reduce clock frequency to save power if processing data with a low symbol rate.

Block 3: Power supply and power distribution

In the standby mode, where there is no self powered auxiliary microprocessor control unit (MCU) an internal power supply will still be active. For STBs using an external power supply, this will always be active and must have good energy efficiency characteristics. Power supply conversion efficiency at light load becomes important both in external and internal supplies.

Block 4: Digital I/O and Modem

Where required these circuits may be idle for much of the time, even when the rest of the STB is fully active.

1.3 Test standards

This section of Task 1 reports on the investigation of those standards, relevant to the measurement of the environmental performance of digital television STBs and approved by Internationally recognised standardisation bodies, or where relevant Industry Associations. The Internationally approved standards often share ratification and are published as European Standard / Norme (EN) and International Electrotechnical Commission Standard (IEC) under a common reference number and title.

A typical test regime for a digital television STB to be brought to the European market encompasses three categories of Test Standard:

• those relating to power consumption

• those relating to health and safety

• those qualifying electromagnetic compatibility.

Not all of the testing according to these standards is mandatory. A recent example of the compulsory or client specific standards testing regime for a current STB product from a major European manufacturer[3] is:

Safety

[IEC60065:2001]

[EN60065:2002] Audio, video and similar electronic apparatus – Safety requirements

EMC

[CISPR 13:2001 + A1/03]

[EN 55013:2001 + A1/03] Sound and television broadcast receivers and associated equipment -Radio disturbance characteristics - Limits and methods of measurement

[CISPR 22:1997 + A1/00 + A2/02]

[EN 55022:1998 Class B +A1/00 +A2/03] Information technology equipment - Radio disturbance characteristics- Limits and methods of measurement

[3]) Pace Micro Technology plc.

[CISPR 20:2002 + A1/02]

[EN 55020:2002 + A1/03] Electromagnetic immunity of broadcast receivers and associated equipment.

[CISPR 24:1997 + A1/01 + A2/02]

[EN 55024:1998 + A1/01 + A2/03] Information technology equipment – Immunity characteristics - Limits and methods of measurement

[IEC 61000-3-2:2000]

[EN 61000-3-2:2000] Electromagnetic compatibility (EMC) Part 3-2: Limits- Limits for harmonic current emissions (equipment input current up to and including 16A per phase)

[IEC 61000-3-3:1994 + A1/01]

[EN 61000-3-3:1995 + A1/01] Electromagnetic compatibility (EMC) Part 3: Limits Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current * 16A per phase and not subject to conditional connection

Surge Testing

[EN 55024] Surge testing

For the purposes of this preparatory study only the standards directly relating to environmental performance as defined in the MEEUP methodology are considered relevant and these are specifically for power consumption testing.

International standards

EN/IEC 62301:20005. "Household Electrical Appliances, Measurement of Standby Power"
The scope of the standard is the measurement of electrical power consumption in the Standby mode. The standard is not limited to consumer electronics, but can be used to measure power consumption in low power mode of all electronic appliances. Useful guidance is given on metering requirements and methodologies for low power measurement. This standard is currently under review.

IEC 62087:2002 / EN 62087:2003 "Methods of measurement for the power consumption of audio video and related equipment"
The scope of the standard includes the specification of methods of measurement of the power consumption of digital terrestrial, digital cable and digital satellite STBs and the definition of the different modes of operation relevant to the power consumption. Test conditions and signals are covered in detail but the methodology does not extend to STBs with integrated recording or DVD playback capability.

Industry Association Standards (USA)

CEA-2013-(A) "Digital STB Background Power Consumption". The scope of CEA-2013 is: Measurement and maximum limit of Standby Mode ONLY for digital STB.CEA-2013 defines maximum background mode (SLEEP state) energy consumption of basic digital

STBs, whose primary function is video reception and delivery. SLEEP state energy consumption is important since Digital STBs spend large amounts of time in this state when consumers are not watching television. CEA-2013 also provides a detailed SLEEP state power measurement specification and procedure, which is included in Annex A. CEA-2013 Annex A can be used as the test method for specifying SLEEP state power of any STB, including types with advanced features. Measurement methods defined in CEA-2013 are applicable to both basic and advanced STB types.

Since the three standards mentioned were developed with a different working group briefs it is worth summarising and comparing the key operating modes and test conditions

Comparison of IEC 62301 – IEC 62087 – CEA 2013 where relevant to STB Power Consumption Testing

EN/IEC 62301	IEC 62087	CEA-2013
Measurement Modes: Standby	Measurement Modes: Disconnected, Off, Standby Passive, Standby Active low, Standby Active high, On.	Measurement Modes; Off, Sleep, On.
Temperature: 23 degrees +/-5 degrees C.	Temperature: 15 to 35 degrees C with 20 degrees C preferable.	Temperature: 22 degrees C +/-4 degrees C.
Instrument accuracy: 10W or less, 0.01W. 10W up to 100W, 0.1W. Greater than 100W, 1W.	Instrument accuracy: Not given	Instrument accuracy: Resolution to be 0.1W or better. True power watt meter preferred.
Not specific to STBs but detailed methodology on low power measurement	Specific to digital television STBs with detailed coverage of test signals and external loads	Specific to digital television STBs Includes Treatment of parasitic peripherals, such as LNBs and security cards

Three primary Test Standards should be considered in the power requirement testing of “Simple “STBs:

- EN/IEC 62301 for guidance on low power (standby) testing (it was noted that this Standard is concluding a revision process)
- IEC 62087 for guidance on product set- up and test conditions (it was noted that the STB part of this has just commenced a revision process)
- CEA – 2013 for guidance on product set-up

The following test methodology is recommended for the on-mode and standby mode testing of Simple STBs with and without HDD or other digital TV transport stream storage features. Test conditions should be those given in IEC 62087

Test measurements should follow the guidance given in IEC 62301 “Appliances – Measurement of Standby Power”, for both standby passive mode and on-mode. Particular reference should be made to the guidance given in this standard on power metering methodology and meter specifications for given load stability characteristics.

The product should be tested at the mains voltage for the European Market (230VAC) under the voltage fluctuation and harmonic content limits given in this standard.

The product should be tested with the manufacturers default settings. It should be receiving a locally modulated or off air digital TV signal. It should be connected to a TV receiver displaying picture and reproducing sound from that signal. Where the STB TV connection interface and format has a choice of standards, the highest standard should be selected for the on-mode measurement (e.g. High Definition, rather than Standard Definition where relevant and for baseband video component rather than composite connection where relevant) Power should not be drawn in both standby and on-mode testing from signal interfaces providing power to external devices (e.g. LNBs, active antennas, USB devices)

As a reference for tests available, the results of five test runs by Stiftung Warentest concerning STBs are displayed below with their relevant results.

Satellite STBs November 2005 (STBs as they were available in Germany in 2004.) [4]

STB	1	2	3	4	5	6	7	8	9	10	11	12	13	14
hard disk	HD	HD	HD	HD	HD									
middle price	600	450	450	229	400	50	150	105	89	99	40	89	89	79
standby W	2,8	7,4	5,3	5,8	12,5	1,4	3,0	7,5	7,2	7,8	6,8	7,2	10,1	12,9

Terrestrial STBs (DVB-T) March 2006 [5]

STB	1	2	3	4	5	6	7	8	9	10	11	12	13
hard disk										HD	HD	HD	HD
middle price	125	93	96	117	80	186	74	68	69	190	465	209	400
standby W	0,7	2,8	2,4	4,7	6,8	13,9	8,4	8,8	9,0	1,6	6,4	8,3	17,3

Satellite and cable (c) STBs (DVB-S / DVB-C) November 2006 [6]

STB	1	2	3	4	5	6	7	8	9	10 (c)	11 (c)
hard disk	HD	HD	HD	HD							
middle price	465	128	185	590	168	37	124	41	58	150	147
standby W	0,2	4,0	7,9	9,6	1,7	1,7	5,0	5,9	6,4	2,5	4,5
On-mode W	22,5	12,5	17,3	23,5	7,6	6,4	12,8	11,4	10,7	6,0	6,0

[4]) Stiftung Warentest: test 11/2005 p. 42-46
[5]) Stiftung Warentest: test 3/2006 p. 44-57
[6]) Stiftung Warentest: test 11/2006 p. 42-46

Terrestrial STBs (DVB-T) March 2007 [7]

STB	1	2	3	4	5	6	7	8	9	10	11	12
hard disk										HD DVB-T +DVB-S	HD	HD
middle price	149	59	100	79	95	45	89	140	160	184	520	360
standby W	2,3	3,8	4,6	6,2	3,4	4,0	4,2	13,8	0,6	8,0	5,7	12,5
On-mode W	6,8	5,9	5,1	7,3	4,4	5,1	4,8	14,8	5,3	14,2	22,7	18,3

Satellite STBs November 2007 [8]

STB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
hard disk												HD	HD	HD	HD
middle price	120	60	60	138	100	109	79	89	149	99	299	370	400	179	230
standby W	2,5	0,9	0,7	3,1	2,1	6,9	7,7	5,8	8,4	8,4	14,5	3,9	7,3	9,0	13,3
On-mode W	8,7	7,1	7,1	7,7	6,2	11,1	11,8	10,9	11,3	13,0	15,0	24,5	11,3	20,3	23,4

Table 1.1: Tests Results of Stiftung Warentest

[7]) Stiftung Warentest: test 3/2007 p. 42-46
[8]) Stiftung Warentest: test 11/2007 p. 55-59

1.4 Existing Legislation and Voluntary Agreements

1.4.1 European Legislation

There are four European Community Directives covering relevant for simple STBs:

- Directive 2002/96EC (WEEE)
- Directive 2002/95/EC (RoHS)
- Low Voltage Directive (LVD) 73/23/EEC
- Electromagnetic (EMC) Directive 89/336/EEC, amended by Directive 92/31/EEC

1.4.2 Eco-Labelling and National Programs for energy efficient Set-top Boxes

The following table displays the programs on efficient STBs and related eco-labelling projects, the respective requirements and the target dates.

National Programs for energy efficient Set-top Boxes and related equipment [9]

Country	Programme	Scope	Summary of requirements				Program Type	Date
			Max Passive Standby	Max Active Standby	Max Active/on	Other		
Australia	Australian Greenhouse Office	Standard definition converter for terrestrial signals	1W or 2W	8W or 7W +Fas to limit of 15W	8W or 7W +Fas to limit of 15W	-	Minimum Energy Performance Standards (mandatory)	Targeted for 01.10.2007
		High definition converter for terrestrial signals	1 W or 2 W	12 W or 11 W + FAs to limit of 19W	12 W or 11 W + FAs to limit of 22W			
Canada	Energy Efficiency Regulations	Simple digital-to-analogue converter box for terrestrial signals	1 W		8 W	Regulation not yet defined	Minimum Energy Performance Standards (mandatory)	Pre-publication date December 2008. Effective date TBD
China	China Standard Certification Center [10] (CSC/CECP)	Simple STBs (Cable only)	1 W		8 W	Automatic power down (After 4 hours of inactivity with alert message 2 Minutes before)	Endorsement Label	Targeted for end of 2007
	China National Institute of Standardization (CNIS)	To be determined	To be determined				Minimum Energy Performance Standards (mandatory)	Targeted for 2008

[9]) Source: IEA International Workshop on Energy Efficient Set-Top Boxes Paris 2007, CSC: Technical Specification for Energy Conservation Product Certification for Digital Cable Receiver Decoders (STBs) and others.

[10]) CECP was reorganized into the China Standards Certification Center (CSC) in 2004. Both names are still available.

Country	Programme	Scope	Summary of requirements				Program Type	Date
			Max Passive Standby	Max Active Standby	Max Active/on	Other		
EU	European Code of Conduct for Digital TV Services	Complex STBs	3 W	7 W (C) 6 W (T, D) 8 W (S) + FAs to limit of 15W			Voluntary Agreement	Current to 31.12.2007
		Digital TVs with integrated receiver and decoder	1.5W	8 W (C) 7 W (T) 9 W (S) + FAs to limit of 16W				
		Analogue PVR	3 W	6 W				
		Simple STBs (no CA)	2 W		7 W (C, T, D) 10 W (S)			
		Simple STBs (High Definition TV) – SD o/p	2 W		11 W (C, T, D) 14 W (S)			
		Simple STBs (High Definition TV) – HD o/p	2 W		12 W (C, T, D) 15 W (S)			
GEEA [11]	Group for Energy Efficient Appliances (Reference: CE03-2007)	Digital to analogue converters (simple converter boxes)	2 W # or less	Terrestrial 7 W	(+ 4##) W or less			
				Cable 7 W	(+ 4##) W or less			
				Satellite 10 W				
				IP (DSL) 7 W	(+ 4##) W or less			
					(+ 4##) W (+ 2###) W or less			
Korea	Energy Boy Standby Power Program	TV with integral pay TV set-top box			8 W + FAs to limit of 15W		Endorse-ment Label	Replaces current requirement from 01.7.2007
		Simple digital-to-analogue converter box for terrestrial signals	1 W		8 W + FAs to limit of 15 W			
		Pay TV set-top box box	1 W (optional)	8 W + FAs to limit of 15 W				

[11]) GEEA Group for Energy Efficient Appliances
The allowance of 4 W is for simple converters for High Definition TV services (both Standard Definition and High Definition output).
If the DSL box includes the ADSL modem then there is an additional 2 W allowance in on mode (this allowance is valid only for DSL boxes

Country	Programme	Scope	Summary of requirements				Program Type	Date
			Max Passive Standby	Max Active Standby	Max Active/on	Other		
Switzerland	Swiss Federal Office of Energy	Same as EU Code of Conduct	Same as EU Code of Conduct				Endorsement Label	Current from: 01.1.2006
Taiwan	Standby Power Promotion Alliance	Set Top Box	2W				Voluntary Agreement	By 2008
USA	Energy Star	Simple digital-to-analogue converter box for terrestrial signals (DTA)	1W		8W	Automatic power down	Endorsement label	Current from: 31.1.2007
		Set top boxes other than DTAs	To be determined				Endorsement label	Proposed effective date: 01.6.2008
	National Telecommunications and Information Administration (NTIA)	Simple digital-to-analogue converter box for terrestrial signals (DTA)	2 W			Automatic power down	Criteria for national subsidy of US$ 40 per STB (max 2 per household)	Current
UK	Energy saving Trust	Simple STB (DTA) for Terrestrial Digital TV MPEG 2 SD output	2007 - 2.7W 2009 - 1.7W 2010 – 1.0W		2007 – 5.8 W 2009 – 5.3 W 2010 – 4.7 W	Automatic Power Down	Endorsement	Label Current
		Simple STB (DTA) with HDD recording capability	2007 – 3.0W 2010 – 1.0W		40.0 W (Under Review)	Automatic Power Down		

1.5 Conclusions

• Following the definition process for simple STBs the focus of the study is on set-top-boxes with no conditional access (CA) and no always-on function (AO) Simple STBs with additional features such as DVD playback and/or hard disks are covered as well.

• Subject to stakeholder input, it is argued that Digital Video Recorders (DVR - or sometimes called DTR) with an integrated digital television receiver, that record to a standard removable library medium, are not within the scope of the study and represent a specific product genre other than STB.

• Simple STBs are only an intermediate product class that is likely to end production shortly after the implementation of digital broadcast systems throughout Europe is completed.

• The simple STB product is already produced in large volumes at very low market entry point pricing. Chinese manufacturers are likely to carry the main share of this production in the lifetime of the product genre. It is important that the energy efficiency criteria for these products has better International Harmonisation, to ensure that the cost benefits of volume production to a common standard, are invested in efficient design and components. Close co-operation with the Chinese certification body CSC/CECP is an important preliminary recommendation to target a narrow window for Internationally harmonised standby mode, on-mode and additional function power requirements.

• The expected lifetime of first generation simple STBs is likely to be short by comparison with other CE products. They will be disposed of when the legacy analogue product they support is replaced by a TV with an integrated digital reception platform or when more functionality is required in the STB such as high definition broadcast reception, recording capability and DVD playback capability. These higher functionality products may prolong the lifespan of the product well beyond the end of the analogue switch off timetable for Europe. This is an important consideration in the assessment of the principle environmental impact of the product – the demand on electrical energy

2 Task 2: Economic and Market Analysis

2.1 Introduction

Task 2 focuses on an analysis of the market for Simple STBs. The analysis is broadly divided into two topics:

- The actual market situation and market potential for simple STBs
- The market trends for Simple STBs

The product types covered are Simple STBs for DVB-T (digital video broadcasting – terrestrial), DVB-S (digital video broadcasting – satellite) and DVB-C (digital video broadcasting – cable). Simple STBs for DVB-H (digital video broadcasting – handheld) and IPTV (internet protocol television) have no significant market penetration and are not considered relevant primary platforms for the simple conversion of analogue TV products to mainstream digital broadcasting reception. DVB-H and IPTV technologies are mentioned in the study, only for reference.

2.2. Generic Economic Data

2.2.1 EU Trade Statistics

The basic statistical information available from EUROSTAT gives just rough numbers for production, import and export. A problem is that in the Eurostat statistics, Simple Digital TV STBs or even digital TV STBs are not classified. Since there is no category for Simple STBs the data available from Eurostat is not useful in the quantification of the volume of Simple STBs in operation within the EU. The only two Prodcom-Codes relevant are "Tuner blocks for CTV/VCR" and "SAT boxes.[12]" It is acknowledged that the process of detailed product categorisation and the collation of related data, in Eurostat, often falls far behind products incorporating fast developing technologies and functions. Eurostat gives no data qualifying digital STBs and is unlikely to ever subcategorise these to the level of simple STBs.

Since Eurostat data is not available in the necessary quality, other sources of market data and product stock detail have been analysed for this study.

2.2.2 Production Base of Simple STBs

While it is not possible to gain quantitative Simple STB data from Eurostat some qualitative information from the Eurostat data can be used to show TV-related product manufacturing and trade. From the data the growing volume of TV- related devices or STB components manufactured in Europe since 2000 is identifiable as well as the countries contributing to this manufacturing. Since the number of STB manufacturers in most EU countries is very low, the production data of these manufacturers is suppressed in the statistical data for reasons of confidentiality.

Eurostat data shows that the production bases for TV tuners and Satellite receivers are not distributed evenly over all EU countries. The countries with a relevant recorded production base in 2006 are: France, Germany, United Kingdom, Denmark, Portugal, Belgium, Lithuania, Hungary and Bulgaria.

A growing amount, particularly of simple STBs is manufactured in the Pacific Rim area, with by far the largest production base centred in the Peoples Republic of China. At present most digital STBs "Made in China" are basic STBs for satellite and terrestrial broadcasting. China

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[12]) The VHK-methodology states that the product categories to be assessed in base cases must be possible to identify in the market figures. This complicates the study if, as suggested in the VHK methodology Eurostat is the to be the key source for market information. For the digital TV STB Eurostat is very poor if not irrelevant in categorising and providing market information for this kind of product. As a general observation the main weaknesses of the data in PRODCOM for fast developing CE products are:

1. Data for the different countries are only available from their entry into EU
2. For countries with few manufacturers, the production figures are hidden due to rules within Eurostat (competitive secrecy). This means that some countries show negative values for new equipment.

produced more than 17 million digital STBs in 2004, which is about 35 % of the total worldwide market. As the demand for DVB-T and DVB-C in both China and the rest of the world intensifies, the Chinese digital STB production is expected to increase at a rate of 21% per annum over the next few years and is forecast to reach 56 million units by 2010. China is expected to supply more than 50 per cent of the worldwide market for digital STBs by the end of this decade.

In 2004 there were 6 ODMs / OEMs[13] and 62 STB manufacturers in China with products that could be categorised as low end Simple STBs. The large majority of STBs manufactured in China are for the export market and in 2005; this comprised 70% of total STB production.

Intense competition has driven the shop counter price of STB products to their lowest level since manufacturing started. Several major names in International manufacturing have left the product sector. Specialist manufacturers with long-term design expertise going back to the analogue STB market still flourish but tend to concentrate on complex STB products. The simple STB market is shifting more and more to suppliers sourcing their products through the ODM / OEM process. The manufacturing base for this process is rapidly centring on the peoples Republic of China.

In parallel with the shift from traditional TV manufacturers to suppliers using their own brand for distributing the STBs the bulk of STB retailing is moving from traditional Audio/TV outlets to computer stores, supermarkets, food discounters and others. These outlets can order and sell quickly, very large volumes of comparatively low cost products. This retailing trend has reduced the selling price of simple STBs to a very low level and has put intense pressure on manufacturing cost and quality.

2.2.3 Trade of Simple STBs

Simple STBs are traded between EU countries. It is known that import into respective countries peaks rapidly during the introductory phase of digital broadcasting and levels off gradually with occasional peaks driven by digital service publicity. The final peak occurs when analogue service switch-off becomes imminent. From industrial sources the following figures are available: In 2004, the global turnover of STBs was 90 million units. The turnover in the European market was 26 million units, of which, 50% were used to receive free television broadcasting.

[13]) ODM: Original Design Manufacturer, OEM Original Equipment Manufacturer

2.3 Current Market and Stock Data

2.3.1 Commercial Market Research Data

Commercial market research data on STBs in Europe tends to focus on the retail volumes in the dedicated or traditional retail outlets. Supermarkets and Discount Superstores are now a principle outlet for large volumes of low cost OEM own-brand STB products but these volumes are often not reflected in such research data.

Accurate estimates of STB sales from commercial market research are further complicated by the limitations of that research into e-commerce. EBay and similar e-commerce is only partly covered and the majority of the e-commerce data is drawn from the extended on-line business of the "traditional" retailer. E-commerce trading from outside the EU is not likely to be covered at all. Volume data from commercial sources on STBs distributed by network operators requires careful analysis and is invariably restricted to Complex STBs

2.3.2 Study Approach to Gathering Market and Stock Data

Because of the perceived limitations in data available from commercial market research, "Market and Stock" data for this task are drawn from a study of:

- The European analogue TV product stock that will need conversion to digital TV to access normal broadcasting services.
- Authoritative data on the pan-European digital switchover programme (see Table 2.1).

Country	Households with TV x 1,000	Terrestrial in %	Potential Market x 1,000	FTA	Start	Analogue Switch Off (ASO)	Transition Period
Denmark	2,400	20 - 25 %	480-- 525	yes	April 2006	October 2009	3 years
Finland	2,300	43 %	1,000	yes	August 2001	September 2007	6 years
France	24,120			yes	March 2005	March 2010	5 years
Germany	36,180	5 %	1,370	yes	October 2002	2010	*8 years*
Italy	22,800	73 %	16,640	yes	December 2003	2008	5 years
Norway		30 %		yes	December 2006	December 2009	3 years
Spain	14,900	*73* %	10,875	yes	November 2005	April 2010	4 years
Sweden	4,000	34 %	1,360	yes [14]	April 1999	February 2008	8 years
UK	24,830	57,5 %	14,280	yes	October 2002 [15]	2013	11 years
Austria	3,280	14 %	450	yes	2006	2010	4 years
Belgium	4,400	3 % [16]	132	yes	2002	2010 [17]	8 years

[14]) DTT in Sweden dominated by encrypted subsciption services
[15]) Re-launch of DTT FTA service
[16]) Including secondary TV sets and tose in vacation homes probably 35 % of population rely on

Country	Households with TV x 1,000	Terrestrial in %	Potential Market x 1,000	FTA	Start	Analogue Switch Off (ASO)	Transition Period
Ireland	1,350	37 %	499			(2015)	
Netherlands	6,700	1 %	67	yes [18]	2003	December 2006	3 years
Portugal	3,200	67,2 %	2,150	yes		2012	
Poland	12,700	46 %	5,842			(2015)	
Romania	6,600	45 %	2,970			(2015)	
Hungary	3,800	34 %	1,292			(2015)	
Czech Republic	3,700	68 %	2,516	yes	2005	2010	5 years
Bulgaria	2,700	32 %	864			(2015)	
Slovakia	1,900	60 %	1,140			(2015)	
Lithuania	1,300	56 %	728			(2015)	
Latvia	800	42 %	336	yes		(2015)	
Slovenia	700	34 %	238			(2015)	
Estonia	600	49 %	294	[19]		(2015)	

Table 2.1: Switchover Table for DTT in Europe [20]

According to the European household survey, in 2005 50% of European households accessed normal broadcasts using a terrestrial TV platform *(See Table 2.1)* 33% using a cable TV platform and 22% a satellite TV[21] platform. Only 5% used a digital terrestrial TV platform with a room or house antenna. This is the average for EU 25. Because of fundamentally different, cable infrastructures, and transmitter network development, the distribution of platform types for TV reception varies significantly from one country to another. For example, in Spain the terrestrial TV platform is used by 90% of households while only 9% use cable TV. Germany on the other hand, has less than 5% of all households using a terrestrial TV platform and 56 % using a cable TV platform. These differences will impact significantly on the volume of Simple STBs required by each country to support analogue to digital switchover. It is likely that most of these STBs will be terrestrial digital platforms (DVB-T) since existing TVs using a cable or satellite platform that covers normal broadcasting are unlikely to require an additional STB.

terrestrial TV
[17]) ASO for Flemish Community
[18]) only one FTA service
[19]) Expected to be available soon
[20]) Source:"EBU/DigiTAG" (data from 2004) and others
[21]) E-Communications Household Survey: http://ec.europa.eu/public_opinion/archives/ebs/ebs_249_en.pdf, July 2006

2.3.3 Presented Data – Assumptions and Qualifications

The data in this section draw on information [22] or assumptions about the implementation of DVB-T in the EU member countries. This information and the assumptions are qualified in the following general statements. Statistical databases are displayed for the biggest markets, as they are more relevant to the stock calculations. The number of Simple STBs in each country will depend on the broadcasting implementation strategy in that country. Countries that focus on Pay TV for the implementation of digital TV will have fewer Simple STBs since Pay TV needs complex STBs equipped with CA features to secure the service provided. In some countries DVB-T is only used by public TV networks. Subscription Service Providers generally prefer to carry their core network on cable and satellite broadcasting. They may augment the service with access to terrestrial programmes but this invariably involves a Complex STB.

The sales of Simple STBs for DVB-C are very low in Europe. One reason is the dominance of Satellite digital TV broadcasting in major countries. Another is that those European countries with a good broadband cable infrastructure, such as Germany, invariably require cable platforms with Conditional Access and often have "always on" functions associated with Internet features. The cable STB platforms required, are invariably "Complex".

2.3.4 Stock Data

In Table 2.2 stock data for terrestrial Simple STBs has been extrapolated for the EU25 from the actual or estimated commencement of digital terrestrial broadcasting in 2000 until 2020 (the year 2000 being the earliest with relevant stock data) By 2020 it is presumed that the Simple STB supporting analogue TV equipment will be a discontinued product genre. The year 2020 seems to be crucial for the calculation of future simple STB stock development since in Europe, analogue switch off and the full implementation of terrestrial digital broadcasting is scheduled for completion by 2016. By 2020 the simple STB may become obsolete [23] and only be replaceable from existing stocks. Volume manufacture will not be required, and small-scale production of a low feature product is not likely to be commercially viable. Well before that time, it is likely that analogue TV production will have been largely replaced by IDTV production[24] and that the normal "churn" volume of TV replacement will be totally dominated by IDTVs. Alternatively the Simple STB, purchased at switchover, may just reach the end of its life, and of necessity be replaced by the only available product, a high functionality complex STB.

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[22]) Source: EBU/digiTAG and others

[23]) There is a risk potential for this assumption as STB manufacturers may try to add new features to Simple STBs to extend their market life. See 2.3 Market Trends.

[24]) In 2006 several TV manufacturers confirmed that current TV chassis designs were all capable of incorporating terrestrial digital TV reception platforms (IDTV) Source, EICTA.

	UK			France			Germany		
	Sales	Rep	Stock	Sales	Rep	Stock	Sales	Rep	Stock
Start			2.0			0.1			0
2000	1.0	0.0	3.0	0.0	0.0	0.1	0.0	0.0	0.0
2001	1.5	0.0	4.5	0.0	0.0	0.1	0.0	0.0	0.0
2002	2.0	0.0	6.5	0.0	0.0	0.1	0.5	0.0	0.5
2003	3.0	0.0	9.5	0.0	0.0	0.1	1.2	0.0	1.7
2004	3.2	1.0	11.7	0.0	0.0	0.1	1.5	0.0	3.2
2005	3.7	1.5	13.9	0.5	0.0	0.6	2.0	0.0	5.2
2006	3.5	2.0	15.4	1.0	0.0	1.6	2.5	0.5	7.2
2007	4.0	3.0	16.4	1.5	0.0	3.1	3.0	1.2	9.0
2008	5.0	3.2	18.2	2.0	0.0	5.1	3.0	1.5	10.5
2009	6.0	3.7	20.5	3.0	0.5	7.6	2.0	2.0	10.5
2010	7.0	3.5	24.0	4.0	1.0	10.6	1.5	2.5	9.5
2011	8.0	4.0	28.0	6.0	1.5	15.1	1.0	3.0	7.5
2012	7.0	5.0	30.0	2.0	2.0	15.1	0.0	3.0	4.5
2013	3.0	6.0	27.0	1.0	3.0	13.1	0.0	2.0	2.5
2014	2.0	7.0	22.0	0.0	4.0	9.1	0.0	1.5	1.0
2015	1.0	8.0	15.0	0.0	6.0	3.1	0.0	1.0	0.0
2016	0.0	7.0	8.0	0.0	2.0	1.1	0.0	0.0	0.0
2017	0.0	3.0	5.0	0.0	1.0	0.1	0.0	0.0	0.0
2018	0.0	2.0	3.0	0.0	0.0	0.1	0.0	0.0	0.0
2019	0.0	1.0	2.0	0.0	0.0	0.1	0.0	0.0	0.0
2020	0.0	0.0	2.0	0.0	0.0	0.1	0.0	0.0	0.0

Table 2.2. EU 25 Sales, Replacements and Stock of Terrestrial Digital STBs 2000-2020

Table 2.2 (Continued)

	Italy			Spain			Others		
	Sales	Rep	Stock	Sales	Rep	Stock	Sales	Rep	Stock
Start			0.0			0.0			0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5
2005	1.5	0.0	2.0	1.0	0.0	1.5	1.0	0.0	1.5
2006	2.0	0.0	4.0	1.5	0.0	3.0	2.0	0.0	3.5
2007	3.0	0.0	7.0	2.0	0.0	5.0	3.0	0.0	6.5
2008	3.2	0.5	9.7	2.5	0.5	7.0	4.0	0.5	10.0
2009	4.0	1.5	12.2	3.0	1.0	9.0	5.0	1.0	14.0
2010	5.0	2.0	15.2	1.0	1.5	8.5	10.0	2.0	22.0
2011	6.0	3.0	18.2	0.5	2.0	7.0	15.0	3.0	34.0
2012	6.0	3.2	21.0	0.0	2.5	4.5	20.0	4.0	50.0
2013	4.0	4.0	21.0	0.0	3.0	1.5	40.0	5.0	85.0
2014	4.0	5.0	20.0	0.0	1.0	0.5	50.0	10.0	125.0
2015	3.0	6.0	17.0	0.0	0.5	0.0	10.0	15.0	120.0
2016	2.0	6.0	13.0	0.0	0.0	0.0	10.0	20.0	110.0
2017	1.0	4.0	10.0	0.0	0.0	0.0	5.0	40.0	75.0
2018	0.0	4.0	6.0	0.0	0.0	0.0	2.0	50.0	27.0
2019	0.0	3.0	3.0	0.0	0.0	0.0	1.0	10.0	18.0
2020	0.0	2.0	1.0	0.0	0.0	0.0	0.0	10.0	8.0

Table 2.2 (Totals Summary)

Digital Terrestrial STBs EU 25 Totals			
	Sales	**Replacement**	**Stock**
Start			2.1
2000	1.0	0.0	3.1
2001	1.5	0.0	4.6
2002	2.5	0.0	7.1
2003	4.2	0.0	11.3
2004	6.2	1.0	16.5
2005	9.7	1.5	24.7
2006	12.5	2.5	34.7
2007	16.5	4.2	47.0
2008	19.7	5.2	60.5
2009	23.0	7.7	73.8
2010	28.5	9.0	89.8
2011	36.5	11.5	109.8
2012	35.0	13.2	125.1
2013	48.0	15.0	150.1
2014	56.0	17.5	177.6
2015	14.0	21.0	155.1
2016	12.0	15.0	132.1
2017	6.0	8.0	90.1
2018	2.0	6.0	36.1
2019	1.0	4.0	23.1
2020	0.0	2.0	11.1

From the considered extrapolations presented in Table 2.2 “EU-25 Totals”, it is clear that there is sufficient lead time for an EuP directive to influence the design and manufacturing cycle (typically 18 months) of Simple STBs to reflect eco-design improvements in many millions of STB products.

United Kingdom

UK is the largest and fastest growing Digital TV market in Europe. Complete analogue transmitter switch off is on schedule for 2012. By 2006 there were 17 million Digital TV STBs and around 2 million IDTVs in operation. Sales in 2006 comprised more than 3.1 million STBs and IDTVs and a very low, statistically unusable, volume of Integrated tuner / decoder terrestrial digital TV recorders (DTR/PVR).
Sales of STBs in 2006 were down 2% from 2005.

The growth of IDTV sales is strong, driven by a wide choice of flat panel display models (LCD and PDP) These will be a catalyst for the early disposal of bulky analogue CRT TVs that can’t be moved into smaller rooms and will reduce the requirement for digital STBs.

Nevertheless, the potential UK market is an estimated 30 million digital TV STBs by 2012. The following assumptions are made for the calculation of the STB stock:

The UK has around 2.5 TVs per household, (2 average for Europe EU-25)

In the UK in 2006, 72% of these households could receive Digital TV (18.2 Million)

Satellite digital TV (BskyB) Subscribers 7.7 Million

Digital Terrestrial Television STBs 9.5 Million

Digital terrestrial IDTVs 2 Million

France

Digital terrestrial TV started in France in 2005. Latest figures show that over 6.8 million DTT receivers had been sold or rented in France by the end of 2006. So in France there are over 6.8 million DTT receivers in homes. According to GfK, 4,725,000 receivers have been purchased, of which 2,800,000 are set-top boxes, 900,000 are iDTVs and 950,000 are computers with an integrated DTT tuner. In addition, a further 2,100,000 hybrid DTT receivers are available to viewers via their subscription to other television platforms such as IPTV. Given the differing types of delivery mechanisms 2007 has a figure of 20% penetration so an estimate is based on a stock of 15 million for conversion. It is estimated that 19% of television households accessed digital terrestrial services at the end of 2006, compared with 13% in August 2006.[25] Full analogue switchover is scheduled for 2011.

Germany

In Germany digital switchover started centrally in Berlin-Brandenburg in 2002. Regional switchover in Berlin-Brandenburg was in 2003. Digital FTA services are provided by ARD/ZDF. Commercial (private) broadcasters cover only the most populated regions scheduled for digital switchover [26]. Analogue switch off is scheduled for the end of 2008. Digital TV coverage by population will be about 90%. Coverage by area will be significantly lower since DTT and cable will not cover some areas due to the high network investment cost per household in less densely populated areas.[27] In rural areas satellite TV is already common. Broadband cabling in Germany is available in almost all cities. Fewer than 5% of the households use terrestrial broadcasting. Currently, the penetration of FTA services is low (5% of households), but it is predicted to grow to 30% of all households. Based on this it is estimated that 11 million households will want to access FTA DVB. By 2006 7 million DVD capable reception platforms were sold. With the experience of the poor take up of DVB-T it is doubtful that HDTV via DVB-T2 will become available in Germany.

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[25]) Source: Associated Press Jan 2007

[26]) Private TV broadcasters only supply their programs in the densely populated areas where the switch over started. Commercial TV via terrestrial broadcast does not cover lower populated regions. Even in areas where they are available now they will switch off in the future.

[27]) Coverage of rural areas was given with analogue TV.

Italy

In Italy a set top box subsidy programme has sponsored the introduction of DTT since 2003. It is estimated that 21 million homes will require STBs. Given that the conversion programme is subsidy driven these STBs may not necessarily come under the definition of "Simple STB" No data is currently available to reliably qualify the proportion of simple or complex STBs. Italy is currently behind schedule for the roll-out of the DTT network and analogue switch-off has been postponed until 2008.

Spain

With the failure of the first launch of digital broadcasting services the sales of digital TV STBs in Spain decreased dramatically. The re-launch started in Nov 2005 and full switchover is scheduled for 2010. Estimates are for that the stock of DTT reception platforms in 2007 is 3.8 million. The total stock of DTT STBs to convert existing analogue televisions by 2010 is estimated as 10 million.

Finland

In Finland, the fourth country to launch digital TV service in 2001, full analogue switch off occurred on September 1st, 2007. For cable television broadcasting an additional period of six months was allowed after which all analogue networking must cease. Simple STB sales volume in Finland is likely to be very low going forward with replacement purchases dominated by high functionality (complex) STBs. Options in simple STB developments that may influence replacement sales levels are discussed in section 2.4 "Market Trends".

Sweden

Sweden was the second country in Europe to start DTT broadcasting in 1999. There is a parliamentary decision to switch off terrestrial analogue broadcast services in February 2008. There are no signs this will be postponed. Simple STB sales volume is likely to be very low going forward with replacements dominated by high functionality (complex) products.

The Netherlands

Digital terrestrial television has been available throughout the Netherlands since 2003, based on a subscription service. Because of the large number of households with cable TV digital terrestrial TV first focused on portable devices with comprehensive reception coverage. Analogue switch-off in the Netherlands happened during the night of 10 to 11 December 2006, making the Netherlands the first country in the world to switch off all analogue terrestrial television transmissions. Simple STB sales volume is likely to be very low going forward in the Netherlands because of the total dominance of Cable TV and conditional access requirements for all digital platforms for national broadcasting.

Other European countries

The rest of Europe comprises around 150 Million households. Some smaller countries have started conversion to DTT. For many the decision has not been made yet. For several countries a late start to digital switchover will provide an opportunity to move directly to a High Definition digital terrestrial TV networking. This is likely to be based on the DVB –T2 standard and reception platforms could still fall within the Simple STB definition. The estimated stock of TVs is currently estimated at 1.5 per household and this represents a total stock of around 225 million analogue TVs. EICTA manufacturers are basing large TV assembly plants in Eastern European countries and the local replacement market "churn" to IDTVs is likely to be very rapid once digital switchover is firmly scheduled. The impact of IPTV services carried on newly developed cable infrastructures in large cities may also influence the requirement for terrestrial Simple STBs. Nevertheless it is likely that well over 100 million TVs will require a Simple digital STB to maintain access to FTV broadcast services.

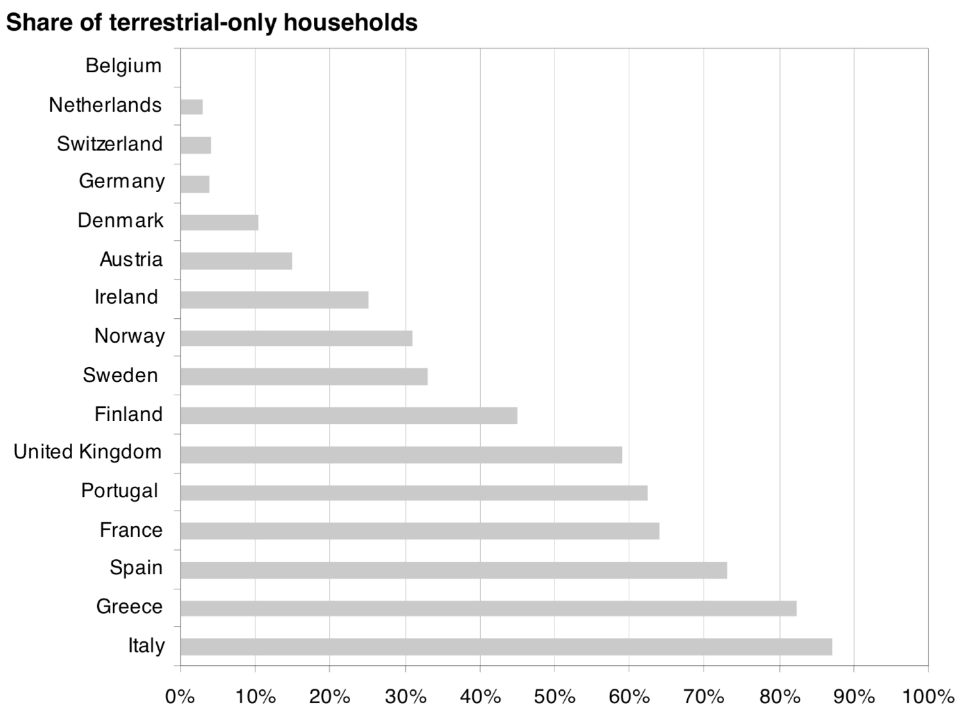

Figure 2.1: Predicted Share of Digital Terrestrial Television Households [28]

[28]) Source: EBU

2.4 Market Trends

Trends in features of Simple STBs are concentrated on the easy storage of programmes and time shift recording. A popular feature of the latter is pause recording and instant replay (particularly endorsed by football viewers). However, manufacturers, driven by competing volume procurers, have an overriding principle - that of reducing costs to market. This draws on technological improvements (higher integration at circuit level) cheaper parts and lower labour costs. Product market appeal is further endorsed at sales level by integrating more features such as DVD-players and storage drives for recording and time shift options.

Simple STBs are essentially an adaptor/converter between digital broadcasting systems and existing analogue TV equipment. Simple STBs are only required as a volume product for a transition period that starts with the implementation of digital broadcasting in a country and ends about 5 years after analogue services are switched off.

By the year 2006 leading TV set manufacturers had many models in their product range that featured an integrated digital tuner/decoder. This will reduce significantly the replacement demand for Simple STBs if their manufacturers decide not to invest in new features to extend the product's market life. [29]

Even if the core encoding technology for each DVB Simple STB is the same a separate dedicated product is needed for each of the DVB-T, DVB-S and DVB-C networking standards. After analogue switch-off, product demand will shrink in a given market and it will be difficult for a manufacturer to maintain commercially viable production of this product range. So STB manufacturers will search for new market opportunities. STBs for new broadcasting technologies such as IPTV (Internet Protocol Television) [30] or VoD (Video on Demand) are unlikely to be available as Simple STBs due to the complexity of the technology used by these systems. Coming technologies such as DVB-H for handheld devices are unlikely to be featured in the Simple STB product genre.

One development in Terrestrial and Satellite DVB that may extend the life of the Simple STB

[29]) Another "surviving strategy" for Simple STB manufacturers will be available if consumer would opt for tuner less TV sets/monitors as now available for the professional sector.

[30]) Telecom companies offer Internet Protocol Television (IPTV). First mass market experiences in Switzerland (Heise.de: Swisscom stellt Vertrieb von IPTV via ADSL ein. 03.08.2007) and Germany show that most existing fixed line telephone networks (DSL) are not adequate in bandwidth and contention factor. Upgrading of the existing network is far to expensive, so the extension of the customer base is on hold until the new VDSL (Very High Data Rate Digital Subscriber Line) network becomes available.
The biggest of Europe's IPTV markets is France and will still be in 2009 by which time there will be 2.4 million subscribers (www.tvover.net November 29, 2005). IPTV is mentioned as an example of digital TV distribution and competitor for DTT. Since IPTV STBs use CA, so they are not covered by this study. Due to cable capacity trouble and new competitors as they are available with the arrival of the P2P IPTV system of the Californian/Swiss company "Zattoo" or the "miro" network the future of IPTV in Europe is not clearly visible for the moment.

genre will be the transition to High Definition TV. Free to view services, mainly carried by satellite will increase in the digital TV transition period. These are based on MPEG-4/ H260 Codec systems and DVB –S2 standards. They will require a new STB. The main market for High Definition terrestrial Simple STBs based on the DVB-T2 standard will be in Eastern European Countries that are likely to be the last to implement digital switchover. These countries are likely to bypass the DVB-T standard definition stage of terrestrial digital TV broadcasting.

High Definition television broadcasting (HDTV) provides a step increase in picture quality, even on standard definition TVs. The higher data rates reduce significantly digital processing artefacts. The latter are particularly annoying to viewers using HD ready TVs, with high-resolution displays, to view SD digital TV transmissions. This issue may be a further driver to extend the life of the Simple STB product genre.

Countries that have just introduced DVB-T will not shift to DVB-T2 immediately. In Germany for example there is a debate on the viability of implementing HDTV, via DVB-T2, at all.[31]

Some new Simple STBs [32] integrate more than one tuner in the box. Some integrate DVB-T and DVB-S. Most use a second tuner/demodulator for viewing and simultaneous recording on an integrated system. Almost all of these hard disk recorders offer the option of time shift viewing to the users own scheduling pattern. Although VHS and DVD recorders allowed this to a limited extent, the scheduling of a wide cross section of broadcast programmes was not possible because of storage limitations. Real time shifting options are only possible with hard disk recording. [33]

2.4.1 New Recording Features for Simple STBs (PVR/DTR [34])

Digital TV technology provides a greater choice of channels and is providing new levels of interactivity that consumers have not enjoyed before. However the fundamental requirement and operational mode of the TV viewer has not changed – i.e. watching live TV. This is about to change, as the falling price of hard disk storage combined with digital TV services, create a paradigm shift in consumer TV watching behaviour.

Personal Video Recorder (PVR) products (also known as Digital Television Recorder -DTR

[31]) heise.de: Erste Fassung der DVB-T2-Spezifikationen soll Anfang 2008 fertig sein. 12.09.2007

[32]) By definition in Task 1 all STBs using their own processor and respective power supply and without CA are Simple STBs.

[33]) For more details about personal video recorders see below.

[34]) The main rival of the PVR is the PC media center. These extended PCs are more complex in handling than PVRs, but offer more features and could be upgraded via hardware upgrade or software upgrade. The two systems focus on different target groups and different life styles. Even for the PC media centers new competitors are arriving with the start of new P2P TV streaming systems such as “zattoo”. This uses a “skype”-like P2P structure.

and Personal Digital Recorder-PDR) are set to become the mainstream product genre. A wave of new product offerings is about to enter the market. The common technology employed in the PVR and digital TV receivers' means that products combining these features are highly attractive for consumers and have real cost advantages.

Like any new innovation, there will be early entrant failures in the market place before mass adoption takes place. There are numerous market levers that will make the adoption of the PVR product, mirror the huge growth seen in the DVD player market over the last five years. Early products such as Tivo and have had limited success for a number of reasons. The main reason is that the revenue model of subscription is alien to customers used to buying VCRs once and only paying for media. Looking at the overwhelming success of the UK Freeview market, with over 9 million receivers sold up to March 2007, it is clear that the "buy-once" model has resonance with the consumer.

The Tivo product was designed to record analogue transmissions digitally onto a hard disk. The product was very expensive because it required expensive analogue audio and video capture circuits and then the additional cost of a hard disk to store the recordings. An expensive product results in too high a price in the retail model, hence it needs to be subsidised in some way to bring it down to a price that consumers would consider acceptable.

The advent of digital TV means that technically costs for PVRs can be driven down because of synergies in the technologies. Combining a digital receiver with a hard disk recorder makes sense because the digital MPEG-2 stream is readily available for recording, avoiding the additional cost of analogue capture (as incurred by the Tivo). Being entirely digital, the recordings are perfect reproductions of the original at the same broadcast quality.

Costs will also fall as there are significant technological advances being made with new chip architectures being released, chipsets being one of the major costs items for any PVR unit. For example an early market entrant the Pace Twin Digital TV Recorder expensively used two MPEG2 decoders and de-multiplex chips for each tuner. The latest generation of silicon has integration of multi-channel decoders on a single die, and also integration of the demodulator resulting in significant cost advantages.

The main additional cost of making a digital receiver into a PVR is the hard disk drive, but hard disk storage costs are halving annually and so dropping faster than silicon. This means that in time it will be possible to offer more storage for a lower price making PVR devices more competitive. To capitalise on this falling price curve, some manufacturers are producing products with removable hard disks.

There are more than 200 million VHS VCRs in the EU, with few being replaced as DVD players now dominate domestic pre-recorded movie playback. By the end of 2007 there will be millions of households with multi-channel digital reception on subscription or free to view STBs and IDTVs who will all find recording a digital channel on to a VHS more trouble than it is worth. Since handling of VCRs, for most users, was a continuous source of trouble they will not miss the product genre, if a new recording device is significantly easier to handle. The demise of the VCR will mitigate the major environmental risk that the product will be left in on mode rather than standby because it introduces an additional remote control function.

A PVR device can offer tens of hours of recording capacity, already far more than a VHS cassette. The disadvantage is that when the disk becomes full, recordings have to be deleted. One solution currently offered is the capability to archive to VHS, but this involves an inevitable loss in quality and takes time. One of the solutions that does not degrade the content and allow perfect copies is the inclusion of a DVD writer into the PVR, or the provision of a 1394 connection for digital transfer to other devices. Combined PVR and DVD recorders already exist, but significant cost reductions need to be made before this is a high volume market product.

DVD video shares the same format as digital broadcasts, (MPEG2) and so it can be recorded onto a DVD. For DVD playback, much of the hardware is the same and can be shared between a digital receiver and a DVD, but integrating a DVD player that can play pre-recorded DVDs into a PVR is more difficult. This is because most pre-recorded DVDs are encrypted using CSS. To play a DVD requires either CSS hardware or sufficient processing power to perform CSS decryption in software. Silicon suppliers may not handle CSS in receiver/recorder silicon because there is no call for it from the large market provided by subscription system PVR procurers.

One of the characteristics of PVR technology is that it offers a wide range of potentially bewildering functionality to the consumer. Research by “Decipher” has shown that there is no “killer” application for PVR, rather that users have different preferences for specific features. Some users simply want to record programs in advance as they did with their existing VCRs. An integrated digital terrestrial receiver and PVR unit makes the whole process much easier with simple access via the EPG. Other users make use of what are termed “trick features” PVR. For example sports fans watching a live game through the PVR, re-winding and re-playing the key events repeatedly, taking up to 2 hours to watch a 90 minute game.

There are new possible interactions potentially to confront the user. For example, users can “stack” a particular program to watch concurrently, such as creating their own omnibus edition of the week's soap operas. However another user may program the PVR to record all content of a certain genre, e.g. Second World War history programmes. Hardware limitations mean that there can be programming conflicts and the PVR interface must be able to deal with this.

There are many players in or poised to join this market. Adding to the familiar challenges of distribution channel and brand, there are some key issues that face manufacturers. Marketing a PVR product presents major issues, as most consumers do not understand what a PVR actually is. Not only does the manufacturer need to explain why their product is compelling, but also has to educate the customer about the full range of applications that PVR technology can provide. We may find PVRs permeate through the purchasing community by word of mouth; similar to the way text messaging in the mobile market grew.

Many players in the market means cost pressure and a drive to differentiate to add value and therefore receive margin. Manufacturers will need to get their products to market as quickly as possible to capitalise on the growing consumer demand and additionally to take advantage of cost innovations with the introduction of new silicon chips.

Manufacturers need to decide how they will maximise the capability of the PVR hardware. For example, a PVR device may have one or two tuners. Each of these tuners is usually used to receive a single digital TV channel, but a single tuner can be used to receive all the channels on a multiplex at the same time. This allows a single tuner to, for example, in the UK, access to ITV1, ITV2, ITVnews and C4. This means up to four channels can be recorded at the same time, and any of these four channels can be viewed while recordings are in progress. With two tuners, recordings from one tuner can be made while watching the output of another removing the need to watch channels related to a recording or cancelling the recording to move to another multiplex. Alternatively both tuners could be used to record up to eight terrestrial channels.

The key challenge is how to present this potentially vast functionality to the consumer. Manufacturers have to trade off the great deal of engineering and human user interface efforts required to build branded, user-friendly and compelling interfaces whilst experiencing intense pressure to get to market.

One of the barriers to market acceptance of the PVR product for the European digital terrestrial television (DTT) market is the lack of a seven-day EPG transmission in the majority of countries. There are technical challenges to overcome, as the mechanism for broadcasting schedule information must use limited bandwidth.

Many homes have more than one television and may have more than one PVR. A proprietary or open standard network interface and peer-to-peer protocol could enable the networking of three dual tuner PVRs together to cooperate and enable the content on one PVR to be viewed on another. With three such terrestrial PVRs any combination of channels could be viewed or recorded on any and all of the six multiplexes and viewed using any of the three PVRs. However such products are likely to fall strictly into the product genre of “Complex STB”

It is clear that PVR technology will become an increasingly important consumer product, although there are wide variations in the predictions of market take-up. However, Cabot, a major software provider for the digital TV industry publicly states the belief that the PVR is strategically important for its digital TV receiver manufacturing partners and in this statement gives a clear indication of the direction the digital TV reception platform will take.

2.5 Consumer Expenditure Base Data

2.5.1 Average Consumer Prices

Market checks done in Germany, France and United Kingdom in August and November 2007 present the following results:

	Medium price of simple STBs	Products supplied by traditional brands
Germany:	35 to 50 Euros	up to about 200 Euro
France	40 to 60 Euros	80 to about 300 Euros
United Kingdom	28 to 85 Euros	

One recent instance of high volume procurement to a rock bottom price and “overnight” sell out was recently noted in the UKs largest Supermarket group with a very basic own-brand Simple Terrestrial STB product marketed at 14 Euros!

	Medium price PVR for DVB-T
Germany:	159 to 399 Euros
France	119 to 199 Euros
United Kingdom	105 to 250 Euros

2.5.2 Running and Disposal Costs

Running costs for Simple STBs are dictated by the price of the electricity used. To keep the costs for electricity comparable between the different studies we refer to “EuP Preparatory Studies “Televisions” (Lot 5), Final Report on Task 2, “Economic and Market Analysis” Table 35: Electricity rates for EU25 July 2005. [35]

Country	Electricity rate [Euro/100 kWh]	Country	Electricity rate [Euro/100 kWh]
BE	14,3	LU	15,0
CZ	8,2	HU	1,1
DK	23,3	MT	7,7
DE	18,0	NL	19,6
EE	7,1	AT	13,9
EL	6,9	PL	8,5
ES	11,0	PT	13,8
FR	11,9	SI	10,3
IE	14,4	SK	12,9
IT	20,1	FI	10,4
CY	12,1	SE	13,8
LV	8,6	UK	9,4
LT	7,2	EU 25	13,6

Table 2.3: Electricity rates for EU25 July 2005

“It can be seen that Denmark has the highest rate with approximately 23 Euro for 100 kWh. In comparison Hungary has the lowest electricity rate with 1 Euro per 100 kWh. The average for EU-25 countries is of nearly 14 Euro per 100 kWh. Belgium, Ireland, Luxemburg, Austria, Portugal, Slovakia and Sweden are all close to that average.” [36]

The replacement cost of many Simple STBs is currently significantly less than or equal to the basic inspection charge levied by electronic product repair workshops. Diagnosing faults other than those associated with the power supply can be time consuming and repairs at chip level very complex. For these reasons, it is unlikely that a basic STB costing up to 60 Euros, will be repaired in its lifetime.

End of life disposal costs for Simple STBs will depend on the recycling procedure to be implemented in each country. Since implementation is not fully established in all EU countries and the structures of these recycling procedures is virtually unknown at Consumer level it is not possible to generate any reliable data on this topic in the case of Simple STBs.

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35) T2 page 53, Source: Eurostat electricity rates for households type Dc (yearly consumption 3.500 kWh incl. 1.300 kWh night electricity part), July 2005 incl. all taxes

36) T2 page 53, Source: Eurostat electricity rates for households type Dc (yearly consumption 3.500 kWh incl. 1.300 kWh night electricity part), July 2005 incl. all taxes

A second obstacle to the collation of realistic data about the end of life costs is the average low age of the Simple STB. Until there is complete analogue switch-off in a country It is obvious that most Simple STBs that become obsolete due to replacement by complex STBs or by a new IDTV, are shifted to secondary TVs or just stored as a spare. It is likely that only a statistically insignificant number of this genre of STB has moved through a structured end of life disposal scheme.

2.5.3 Interest and inflation rates

The following Table 2.4 shows inflation and interest rates for EU25 countries as published by Eurostat and the ECB. Both data categories only reflect national rates and are not product-specific.

Country	Inflation rates [%] (1)	Interest rates [%] (2)	Country	Inflation rates [%] (1)	Interest rates [%] (2)
BE	2,8	3,4	LU	3,4	:
CZ	1,9	:	HU	3,3	6,6
DK	2,2	3,4	MT	3,4	4,6
DE	2,1	3,4	NL	2,1	3,4
EE	3,6	-	AT	1,6	3,4
EL	3,5	3,6	PL	0,8	5,2
ES	3,7	3,4	PT	2,5	3,4
FR	1,8	3,4	SI	2,4	3,8
IE	2,2	3,3	SK	3,9	3,5
IT	2,1	3,6	FI	1,1	3,4
CY	1,4	5,2	SE	1,3	3,4
LV	7,1	3,5	UK	2,0	4,5
LT	3,0	3,7			
EU 15 (3)	2,2	3,4			
EU 25	2,1	3,9			

Table 2.4: Interest and inflation rates for EU-25 countries [37]

(1) Annual Inflation (%) in Dec 2005 Eurostat "Euro-Indicators", 7/2006 - 19 January 2006
(2) Source: ECB long-term interest rates; 10-year government bond yields, secondary market. Annual average (%), 2005
(3) Euro-zone

[37]) Source: “EuP Preparatory Studies “Televisions” (Lot 5), Final Report on Task 2, “Economic and Market Analysis” Table 36: Interest and inflation rates for EU-25 countries.

2.6 Conclusions.

The demand for Simple STBs as a product genre is to allow the economically viable conversion of existing analogue TV stock to digital TV service reception. The ongoing market driver for the product, before analogue switch-off, is the wider programme access and the key driver is the imminence of the switch–off date. As costs fall the advantages of the Simple STBs with HDD recording facilities (PVR) and additional tuners for other DVB services will prove to be a strong market driver.

Manufacturers and retailers predict that basic low feature Simple STBs will leave the European market from the end of the analogue switch off roadmap in 2015. New feature trends may extend the life of the product genre but there will be a clear eco-design barrier to the extent of these features if the product is not to be categorised as “Complex”.

The introduction of HDTV services in countries with established digital SDTV services may be a further driver to extend the market life of the Simple STB.

The rapid penetration and dramatic fall in the retail price of aesthetically desirable flat panel TVs with integrated digital receiver/decoders may prove to be the strongest contributor to the demise of the basic low feature simple STB.

3 Task 3: Consumer Behaviour & Local Infrastructure

3.1 Introduction

The electronic design of Simple STBs is one factor when discussing the environmental impacts of these products. Another factor is the day-to-day usage of such electronic equipment. Are the usage patterns that are envisaged when designing the product still valid when the equipment moves from the “drawing board” to the consumer’s equipment rack? The first TV accessory that dominated the mass market was the VHS video recorder. Throughout the now terminal lifetime of this product, it gathered notoriety for poor ergonomics. Many useful operational features were under used or ignored because of the complexity and non - intuitive nature of the user interface and related instruction manual. Environmentally valuable status control features that could minimise the unnecessary on-mode time of the recorder were often ignored and small house-to-house surveys[38] showed that a majority of these products were left on when the TV was off.

In converting legacy analogue TV equipment to digital TV reception the Simple STBs should, at first consideration, raise no user interface problems. However, the need to use two remote controls, that of the existing TV and that of the Simple STB, to access all of the combined features of the TV and STB raises immediate issues of user behaviour.

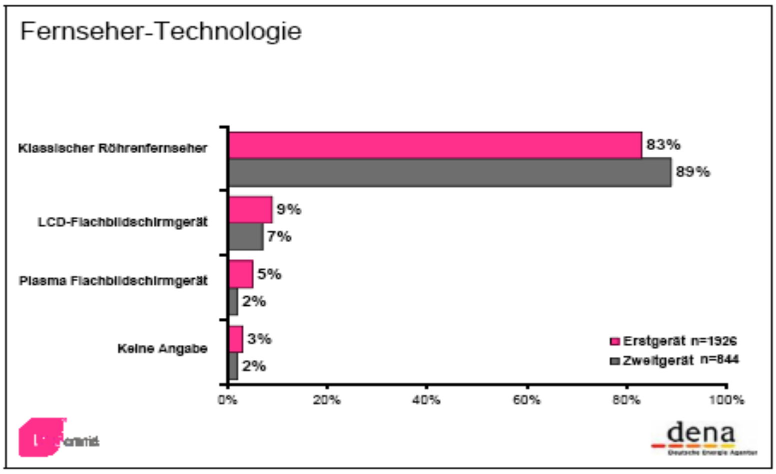

Table 3.1: TV set technology in German households [39/40]

The ergonomics of hardware and software design are an essential topic when a background

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38) UK Consumers’ Association Internal report 2000

39) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006. Page 9

40) Klassischer Röhrenfernseher: CRT-TV set
LCD-Flachbildschirmgerät: LCD-TV set
Plasma-Flachbildschirmgerät: Plasma—TV set
keine Angabe: not specified
Erstgerät: First TV set per household
Zweitgerät: Second TV set per household

product such as the Simple STB influences the specific user behaviour associated with a familiar TV. Very few European surveys are available to the public concerning the impact of user behaviour on the energy footprint of TV peripherals such as STBs, DVD players, Video recorders and home theatre systems.

3.2 Buying decision

There have been various drivers influencing the consumer in the purchase of a STB. With the availability of satellite services and the supply of a growing bouquet of broadcast stations from all over the world, a significant number of consumers complemented terrestrial TV with analogue satellite TV. They then migrated to digital satellite TV STBs as these services took over from the analogue services. Satellite service providers usually drove the migration and the majority of consumers moved to digital STBs before the analogue services were switched off.

A similar movement to complement terrestrial broadcasting came to countries with a good wideband cable infrastructure such as Germany. Unlike digital satellite broadcasting, the transition to digital cable services did not affect a large number of cable customers since many big housing complexes integrated the digital / analogue converters into the buildings TV supply infrastructure. The customers in their flats were supplied with an analogue signal for their conventional TV sets as before.

In most European Nations the transition from analogue to digital terrestrial TV broadcasting is accomplished on a regional basis with plenty of advanced publicity and as in the UK, a long overlap of analogue and digital Services. Many consumers purchase a digital TV STB before analogue switch off to benefit from the wider range of services often offered. But it is obvious that a majority of STBs will be purchased at short notice as the analogue services close. This was the case in Germany, where in some regions the advance announcement of the analogue switch off was given just a few days before the start date of the DVB-T service and was scheduled for the same day. Consumers depending on terrestrial TV had to buy a new Simple STB immediately. In these circumstances the energy footprint of the STB or other eco – design considerations are secondary issues for the consumer.

Even where the consumer has plenty of time to consider what to do about analogue switch-off, the wave of Simple STBs moving quickly through retail outlets in Europe, with rare exceptions, have none of the energy efficiency labelling referred to in Task 1. Where high profile campaigns are in place to label STBs as suitable for digital TV switchover (e.g. UK “digital tick” logo[41]) issues of eco-design are not a priority in the supporting criteria.

[41]) www.digitaluk.co.uk

Most consumers do not associate energy efficiency with a specific TV or STB brand. Campaigns addressing this topic in the past have failed since the majority of consumers and even media commentators, have only a vague concept of the energy demand of TV sets and STBs.

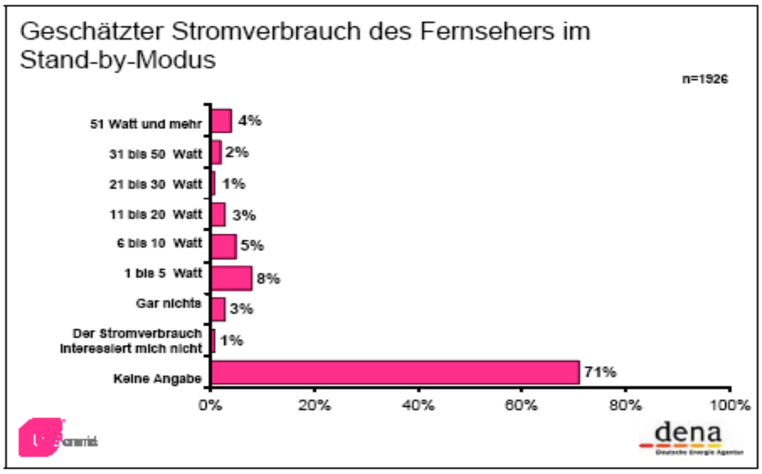

Table 3.2: Energy demand of TV set in standby-mode as estimated by consumers [42/43]

3.3 Frequency and characteristics of use

The most obvious energy consumption factor of any TV receiver is, of course, associated with viewing hours. There is, however, another important factor for TV receivers that are converted to digital TV reception with a Simple STBs. Common remote controls that turn both the TV and the STB into passive standby are rare although they do exist. As a result, It has been asserted[44], that users of STBs often leave them on almost permanently, consuming maximum power, when the TV is put into standby with its own remote control. The UK digital satellite TV service provider, B-Sky-B had sufficient internal survey evidence of this consumer behaviour to make the decision to implement an automatic standby feature in new STBs and those installed STBs that could accept the software download involved. The trend of some manufacturers to release models of STBs that have an automatic power down mode further supports the conjecture that many users do not switch off TV peripherals, if a secondary remote control activity is required.

Several regulatory and voluntary regimes have implemented, or are planning to implement, automatic power down as part of the energy performance requirements for STBs. (e.g. USA-EPA, Australia, EU CoC). Without such a feature Simple STBs may consume more than an order of magnitude more energy in their in-use life cycle.

42) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: "Stromeffizienz bei der Fernsehnutzung" Berlin 2006. Page 12

43) Stromverbrauch interessiert mich nicht: Not interested in energy demand

44) Ongoing large scale customer survey B-Sky-B UK.

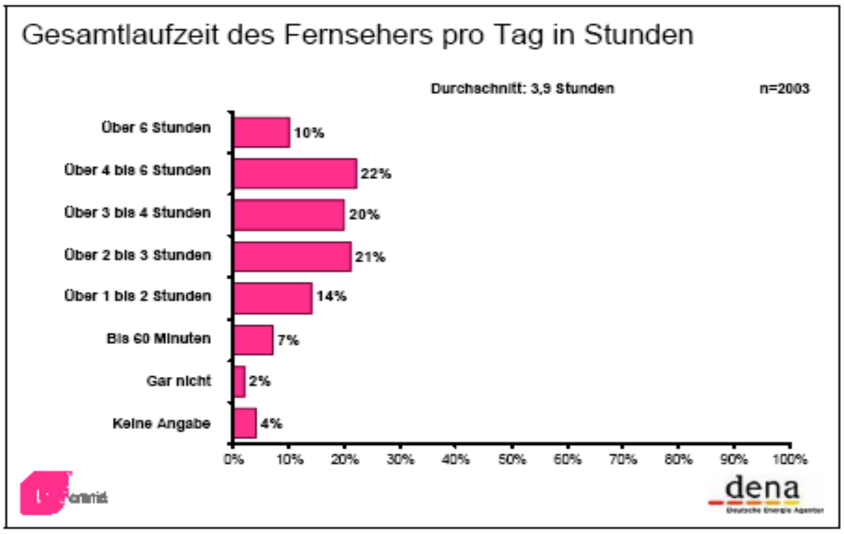

Table 3.3: Use of TV set in hours per day [45/46]

The viewing habits of consumers have been reported at different levels in different regions of the word. In Europe a figure of 4 hours viewing per day is often quoted. This would mean that a STB would at best case be consuming “on” power for 4 hours and “passive standby” power for 20 hours. This can be compared to Australian quoted figures of 5 hours on and 19 hours off and the USA where it has been reported that the “on” figure could be over 8 hours even though an individual is only watching for around 5 hours. This viewing may be spread between two or more TVs in multi-TV households. There is no in-depth research data to show which TVs are left on and which are switched off in such households in a nominal viewing period. There are more viewing hours with families of 4 and more than with single or small households.

[45]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006. Page 4

[46]) Gar nicht: not at all

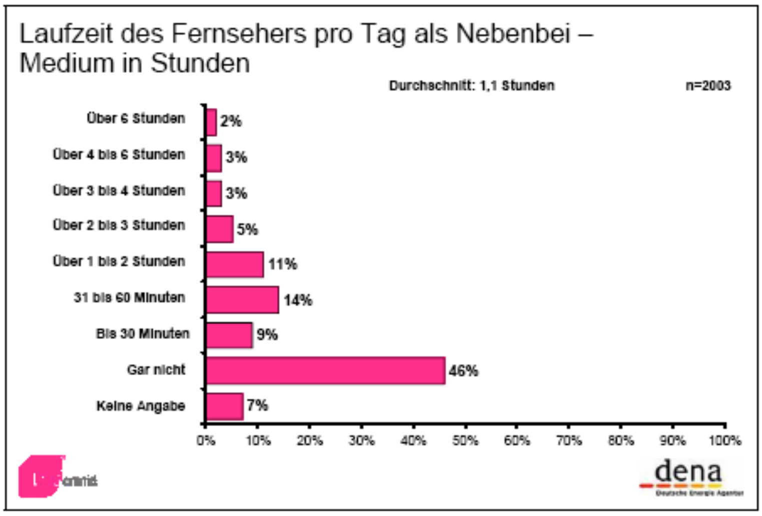

Table 3.4: TV set used for background entertainment (hours/day) [47]

Recent surveys in Germany [48] indicate that most consumers consciously use their TV set for more than 2 hours per day. More than one third are aware of the TV being on for more than 4 hours a day. Younger people often use their TV sets as background entertainment whilst the elderly switch their TV set off, when not watching.

Similar results are presented by the EUP Preparatory Studies “Televisions” (Lot 5) [49]: “Many studies estimate an average on-mode (use) time of 4 hours per day for a single TV in a regular household environment in Europe. Similar average use duration has been the basis for many energy efficiency calculations in the world.” Nevertheless the discussion about the daily TV consumption in European households is still going on. For the further calculations we will use a basic On-mode of 4 hours per day, which is used in EUP Preparatory Studies “Televisions” (Lot 5) as well. [50]:

[47]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006. Page 12
[48]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006
[49]) EuP Preparatory Studies “Televisions” (Lot 5) Final Report on Task 3, “Consumer Behaviour and Local Infrastructure”, Page 8
[50]) EuP Preparatory Studies “Televisions” (Lot 5) Final Report on Task 3, “Consumer Behaviour and Local Infrastructure”, Page 12/13

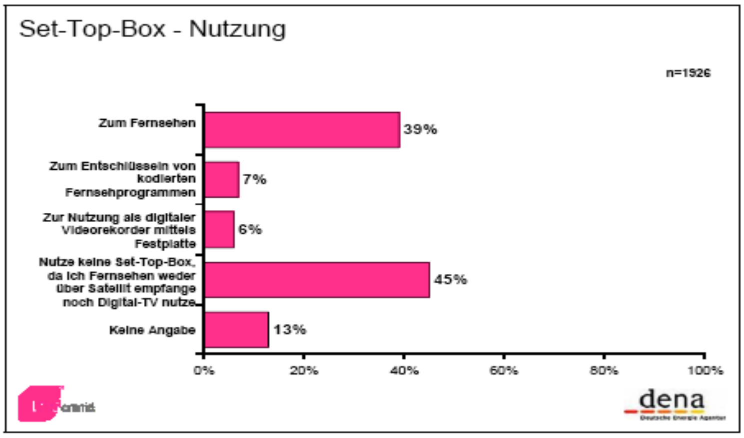

Table 3.5: Purpose of set top boxes in German households [51/52]

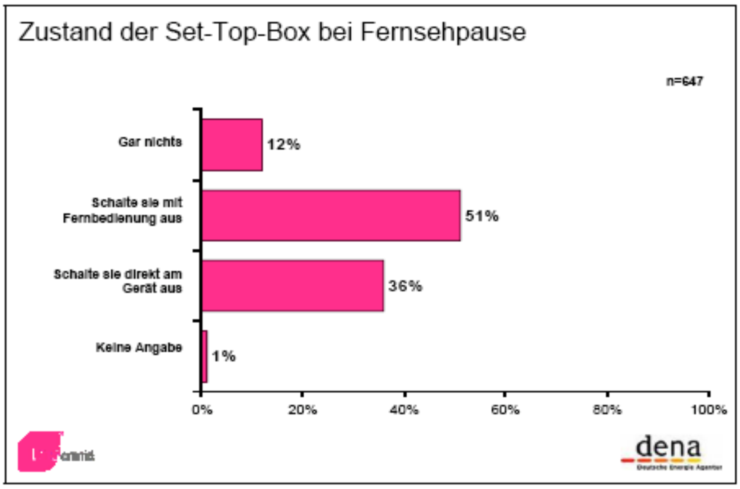

Table 3.6: Consumer behaviour concerning Switch-off of STBs during the day [53/54]

It is clear that care needs to be taken when extrapolating TV viewing hours for life cycle in-use energy requirement assessments. There is clearly a difference between how long a STB is in the “on” state and how long any individual is actually viewing.

Since Simple STBs are not stand-alone devices they need to be switched on with the TV set. We have addressed the question: will they be switched off with the TV set as well? It is estimated that two third of all users of STBs don't switch off using the mains switch of the STB where it is fitted and just switch to standby by remote control (or even keep the STB in on-mode). This latter user habit is even more likely with small form factor STBs that are concealed behind the TV, (e.g. directly inserted into a SCART socket).

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[51]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006. Page 14

[52]) Zum Fernsehen: For watching TV
Zum Entschlüsseln von kodierten Fernsehprogrammen: For conditional access
Zur Nutzung als digitaler Videorekorder mittels Festplatte: used as PVR
Nutze keine Set-Top-Box: no STB used

[53]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: “Stromeffizienz bei der Fernsehnutzung” Berlin 2006. Page 15

[54]) Schalte sie mit der Fernbedienung aus: using remote control to switch off
Schalte sie direkt am Gerät aus: using front switch of STB to switch off

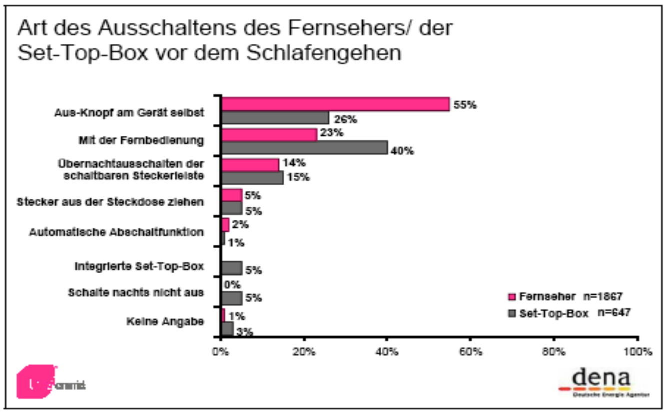

Table 3.7: Consumer behaviour concerning Switch-off of STBs in the evening [55/56]

A radical method to reduce the standby-consumption of electronic devices such as Simple STBs is in the often-suggested use of a hard-off mains switch. With some current STBs this switch is incorporated but usually associated with the mains connector at the back panel. Most consumers won't use a switch located out of site. Where a front on/off-switch is fitted. It is usually only a standby-switch relaying the soft-off function of the remote control.

In the past some TV sets were equipped with a hard-off mains switch that used to be powered by an electromagnetic/spring driven switch (Dangschat patent). Switching off thus worked via remote control. To switch the equipment on was only possible by pressing the mains switch in front of the TV set. The two manufacturers of the electromagnetic spring driven switch - one in Spain and one in Japan - discontinued the production of these switches and will not start production of such devices again. As a do it yourself solution some 20% of consumers use switch-able connection plug boards to switch off their TV equipment including STBs after watching TV in the evening. More elegant solutions to solve the standby/switch-off problems associated with user habits are in the European Market. These usually consist of a mains supply panel with detection circuits, that can automatically sense the on-mode and standby state of the TV and switch power on or off to outlets for peripherals such as the STB. More elegant switching solutions for incorporation in the STB are in development. Using these solutions 0,3 W in standby is possible as well as wake up on demand using many forms of signalling. This development facilitates the program and

[55]) Deutsche Energie-Agentur GmbH (dena): Bevölkerungsbefragung zum Thema: "Stromeffizienz bei der Fernsehnutzung" Berlin 2006. Page 16

[56]) Aus-Knopf am Gerät selbst: using front switch of STB to switch off
Mit der Fernbedienung: using remote control
Übernachtausschalten mit der schaltbaren Steckerleiste: using switchable plug board to switch off
Stecker aus der Steckdose ziehen: pulling the plug
Automatische Abschaltfunktion: automatic switch-off function
Integrierte Set-Top-Box: integrated STB
Schalte nachts nicht aus: do not switch-off at all

data downloads required by some service providers even if the device is actually in standby- or sleep-mode. These developments are covered, in depth, in Task 6.

The demand of software updates in Standby-mode (necessitating a higher standby level than standby passive) is not considered as an important part of the Simple STB duty cycle energy requirement.

3.4 End-of-life behaviour

The relative newness of STB technology makes it difficult to specify the likely end of life issues. A number of factors however can be considered to help model the Simple STB end of life.

The propensity to repair Simple STB will be low, since the original costs of the device is also low compared to other consumer products. In most European countries the minimum handling charge for a consumer electronic product repair is of the order of the average cost of a new Simple STB. Since this average cost is likely to fall year on year replacement rather than repair will be the solution for faulty products inside or outside warrantee periods. Repair cost of a Simple STB would be in the order of the price for a new one.

The evolution of new technologies will also act to limit the life of a Simple STB purchased at the outset of analogue to digital TV switchover. If we consider the current developments in digital TV transmission and reception technology, it is clear that MPEG4 standard definition (SD) and high definition (HD) services will displace MPEG 2 SD services in the European switchover period. As the MPEG technology is backward compatible a newer MPEG 4 STB will also receive all the existing MPEG 2 services as well as the newer MPEG 4 services. This development scenario will occur within a few years of the MPEG 2 services and associated STB sales being established. The interest in DSL technologies (IPTV) will drive further redundancy in those STBs that are currently being sold or that may even have MPEG 4 decoding capability. However such IPTV platforms are likely to fall outside the definition of the “Simple STB”

Replaced “simple STBs” will be discarded after analogue switch off since it is unlikely that any legacy analogue TV equipment will remain in use in any household without a digital TV STB of some kind.

3.5 Local infrastructure

Unlike integrated receivers Simple STBs clearly do not have issues associated with screen size. They do share, however, other infrastructure features that have direct impact on basic energy consumption and/or use.

The important infrastructure parameters for STBs are:

- Service Type i.e. SD or HD;
- Service Platform i.e. Cable (DVB-C), Terrestrial (DVB-T), Satellite (DVB-S);
- Recording Capability;
- DVD-player integrated.

The definition of the service has both direct and indirect eco design issues. The direct issue is the energy required to decode HD signals as opposed to SD signals. Most of the current chip sets that decode HD format broadcasts require around 4 W or more additional power to perform this task. The proliferation of MPEG 4 HD services is already evident and is being received by consumers as a highly desirable feature. In particular sports content in HD is proving to be a well-received service and many major events such as AFL (Australia), US Masters Golf, Rugby World Cup and European Cup (football) amongst others will be broad-cast in HD.

The indirect consequence of service type can qualify the type of display device that is used to display the picture. If a STB is only capable of SD reception it is generally agreed that larger display devices exhibit poor picture quality since the limited available picture information is spread across a larger area. HD on the other hand presents a high quality picture on these displays so the propensity for consumers to purchase, while they are available, analogue TVs with large-screen-LCD and Plasma displays is increased as is the commensurate trend in energy consumption.

The type of Service platform is also an issue, although the obvious platform to dominate analogue TV conversion will be the terrestrial STB since this interfaces directly with the existing antenna arrangements in most homes.

The cable platform does not implicitly require any peripheral energy consuming devices however the cable platform is unlikely to fall under the definition of “Simple STB”

The terrestrial platform may require a masthead amplifier or an active (powered) set top antenna. The former is likely to be self-powered with no control from the STB.

The Satellite platform is required to power the external LNB. However a satellite platform meeting the “simple STB” definition should not require a continuous active standby mode and the LNB power could be power managed to a low level or off when the STB is not in use. Low energy LNB solutions will be covered in Task 6.

The permanent consumption of a distributed TV signal infrastructure in housing complexes is relevant to all platform types. Here, the user is dependant on the infrastructure provided by the owner of the building. Most installations use digital / analogue converters to provide their customers with an analogue signal that could be used by the existing analogue TV set.

Many consumers are becoming attracted to recording capabilities within the STB in the form of a Hard Disk. DVD recording capability is beyond the scope of a Simple STB and must be considered separately (see product definition in task 1). If a STB has a hard disk drive there can be a number of issues that affect energy consumption.

The obvious one is that of the energy required to drive the hard drive. Less obvious ones relate to how a STB is designed to record when not being viewed. Ideally power management should ensure that the STB is virtually in the standby passive state with some allowance for timer functions. When it is woken up to record, only the functions required to store the demodulated broadcast stream to hard disc should be active. At the end of all recording requirements the STB should return to full standby passive state

Although European manufacturers and importers of TVs will make the transition to IDTVs (TVs with integrated digital reception platforms) in the final switchover period for each country, many millions of analogue TVs will be added to household stocks and will require STBs at switchover. The sharp fall in the cost of these TVs relative to average household income (especially small to medium screen LCD display TVs) will support a trend to dispense with large CRT TVs, which are not easily redeployed in smaller rooms. It is likely that driven by analogue to digital TV switchover, particularly in Western Europe, there will be a significant waste problem with large screen CRT TVs and a step up in the average number of TVs deployed (with STBs) in a typical household. The commensurate increase in energy overheads for TV entertainment will be significant

3.6 Conclusion

Consumers will purchase Simple STBs in the transition phase to full digital TV broadcasting, to increase their access to the quality (HD) and range of broadcasting services. At switchover every analogue TV is likely to be converted with a simple or complex STB. The falling cost of analogue TVs relative to average household income is likely to drive up the number of TVs deployed in the average household and commensurately, the number of STBs required at switchover.

In general, for “simple STBs” consumers are focussing on price and to a certain extent on functional features but not on energy consumption. To date all public campaigns to increase awareness of the energy consumption of TV associated products are limited. National campaigns designed to inform the Consumer about digital switchover tend to give energy efficiency criteria the lowest priority.

4 Task 4: Technical Analysis Existing Products

4.1 Introduction

Task 4 focuses on the technical analysis of products now available on the market. Some of the products are distributed in Europe already, others are for now available in overseas markets such as the USA or Australia. Australia, in particular, is ahead of Europe with High Definition Terrestrial Television but the STB technology used will feature in European products soon and it is considered relevant to include these products in the study.

In the consideration of the life cycle impact of materials used in STB production it has to be noted that the STB has several form factors. One is the “traditional” form factor. The casing is of rectangular design, sometimes featuring a display, one or more buttons on the front panel with mains and signal connections on the back panel. The physical size of these “traditional” designs varies enormously. The most compact are usually cased in moulded plastic and often have an external power supply, the larger designs are usually cased in pressed steel.

A completely different and more recent form factor is a very compact design, effectively based on an extended Scart connector, and in some models called “Scart Stick”. These are invariably driven by an external power supply. Because the Scart Stick is located behind the TV, it features a flying lead IR remote control receiver that can be located at the front or side of the TV cabinet.

The STBs examined for this Task are products with a well-established general market rather than “one off” OEM sourced products.

4.2 Pre-production and production phase

4.2.1 Design phase

The most common form factor for Simple STBs is the classic rectangular casing type with a steel box design and a décor front panel made of plastic material. With some Simple STBs the whole case is now made of plastic material.

The displays are normally reduced to the absolute minimum. Most front panels are equipped with one or more LEDs to display the operating status of the STB. Front panel controls are reduced to a minimum and the remote control is usually essential for the normal operation of the STB. All STBs use an OSD (On Screen Display) on the connected TV instead of a comprehensive display on the front of the device. The following pictures show typical examples of “traditional” STB form factor and the “Scart Stick”

Fig 4.1: Typical examples of Simple STBs

In addition to the STBs by traditional CE manufacturers and special receiver manufacturers there are numerous Simple STBs available under a large number of different brands. Most of these devices are imported from China.

To reduce the costs, of materials and transportation the size of the Simple STB is shrinking significantly. An extreme of this trend is in the current miniaturisation of the Scart Stick form factor. These products are now no larger than some Scart-cinch adapters. Several of these devices were displayed at the booths of OEM/ODM manufacturers at the IFA 2007 (Internationale Funkausstellung) in Berlin.

4.2.2 General Technical Specification of the Simple STB

Simple STBs are for the reception, decoding, processing and local networking of digital broadcasting and related services and converting the digital signals to analogue signals compatible with existing analogue TV sets and video recorders.

Simple STBs need a remote control to make use of all their features. Only limited control is given with the buttons on the front of the traditional cabinet type STB. Scart Stick STBS offer no direct access without remote control, since they are located at the back of the TV set out of the reach of the user.

The following components/features are included in the basic configuration of the Simple STB but do no constitute a minimum specification (i.e. they may not be present in the device).

STB			
CABLE	***TERRESTRIAL***	***SATELLITE***	***DSL***
Single cable tuner / demodulator	Single RF tuner / demodulator Active antenna powering	Single satellite tuner / demodulator Single LNB feed	No tuner / demodulator
Single MPEG2 Decoder (SD or HD as appropriate)			
RF Modulator / Loop-through			
IR Remote Control			
Support for Off-air Software Upgrade			
Electronic Programme Guide (EPG)			
Timer control facilities			
Auto standby			
Analogue Composite and Component video outputs			
Single Analogue Composite and Component video input			
Stereo analogue audio out and in			
Operating system support for Interactive Services (e.g. MHEG, MHP, OpenTV)			

Table 4.1 Basic configuration of a Simple STB

4.2.3 Efficient Design and Components

The criteria for efficient design and components are normally qualified in power consumption targets. In this context the study endorses the European CoC[57] process where stakeholders identify a basic configuration with a basic power consumption target for the STB. For additional functions a table of additional power allowances is agreed. All functions that are not covered by the allowance table are covered by the basic configuration (For the

57) Code of Conduct on Energy Efficiency of Digital TV Services

purposes of this study, within the context of the Simple STB definition given in Task 1)

4.2.4 Power Management

Power management is the process that ensures that the STB is always in the mode with the lowest possible power consumption for the functions required at a given time. Basic power management supports the following features:

- Timer control facilities (in standby passive): this feature allows the STB to switch from (and to) the standby passive mode without user interaction. Most STBs have an EPG[58], which allows users to select programmes for recording, either by an external recording device (e.g. VCR) or internally in the STB (e.g. on hard disk). If a programme is selected, the timer control wakes the STB a short time before the program start, if applicable the STB sends a signal to the VCR to start recording. When the programme has finished (according to the data in the EPG) the timer control shuts down the STB if appropriate.
- Auto power down (automatic standby feature): with an On-Screen-Display warning to the user, the STB automatically switches itself into the lowest standby mode (in principle standby passive) after a period in the on mode following the last user interaction and a programme change. The timer control feature always overrides the auto power down feature. Some STBs will simply auto power down at a pre set (or user qualified) time.

4.2.5 Recycling issues in the design of simple STBs

Other environmental issues, besides the power demand of Simple STBs, to be considered by the STB designer are those raised by the choice and fabrication of specific materials. The range and mass of used materials, the marking of materials and the ease of dismantling of the product to basic material components are all design considerations.

The Stiftung Warentest, tests on existing Simple STBs, presented in Task 1 for energy efficiency also identify designs that offer better potential recycling of STB materials and components. For the ranking process, the STBs are opened; the construction details and the marking of materials used are inspected. The ranking is 1 for excellent, 2 for good and 3 for mediocre.

The results of four test runs by Stiftung Warentest, on STB recycling potential, are displayed below. End of life recycling potential is rated as described.

[58]) Electronic Program Guide

Satellite STBs November 2005 [59]

STB	1	2	3	4	5	6	7	8	9	10	11	12	13	14
middle price	600	450	450	229	400	50	150	105	89	99	40	89	89	79
hard disk	HD	HD	HD	HD	HD									
recycle	3	3	2	1	2	1	1	2	1	2	1	1	1	2

Terrestrial STBs (DVB-T) March 2006 [60]

STB	1	2	3	4	5	6	7	8	9	10	11	12	13
middle price	125	93	96	117	80	186	74	68	69	190	465	209	400
hard disk										HD	HD	HD	HD
recycle	2	1	1	2	2	3	2	3	1	3	3	3	3

Satellite and cable (c) STBs (DVB-S / DVB-C) November 2006 [61]

STB	1	2	3	4	5	6	7	8	9	10 (c)	11 (c)
middle price	465	128	185	590	168	37	124	41	58	150	147
hard disk	HD	HD	HD	HD							
recycle	3	3	2	3	1	1	1	1	2	1	1

Terrestrial STBs (DVB-T) March 2007 [62]

STB	1	2	3	4	5	6	7	8	9	10	11	12
middle price	149	59	100	79	95	45	89	140	160	184	520	360
hard disk										HD DVB-T +DVB-S	HD	HD
recycle.	1	1	1	1	1	1	1	1	1	2	3	3

Table 4.2: Test by Stiftung Warentest

The tests by Stiftung Warentest show a quite clear trend to design for recycling in a high proportion of “high end” products. Medium to low end products are disappointing in this context with two exceptions. (For Standby and On-mode consumption data see Task 1)

[59]) Stiftung Warentest: test 11/2005 p. 42-46
[60]) Stiftung Warentest: test 3/2006 p. 44-57
[61]) Stiftung Warentest: test 11/2006 p. 42-46
[62]) Stiftung Warentest: test 3/2007 p. 42-46

4.3 Production phase

4.3.1 Components of a Simple STB

1) Casing of the STB

(a) Steel casing

Steel casings are stamped from treated steel sheet and bent. The primary components usually comprise a one piece top and sides cover and a main chassis which forms the base, the back panel support and front panel support. The front panel of most boxes is made of ABS or PS. The front plate houses some buttons, some LEDs and the IR receiver for the remote control. External Metal surfaces are usually powder coated.

(b) Plastic material casing

The material used for most boxes with plastic material casing is ABS or PS. Due to the advantages of moulding, STB cases made of plastic do not need to follow a strict rectangular design. Some of these cabinets simply comprise a base and a cover part. An integral metal chassis or even the main PC board supports the back panel connectors. Surfaces are coated or are made with coloured plastic.

2) Power supply

Most Simple STBs in a “traditional” casing are equipped with an internal power supply. The typical device uses a switching power supply as an open frame module. Small format “traditional” casing and “Scart Stick” STBs use an external power supply. While some Simple STBs with internal power supply offer a primary mains switch to disconnect the whole equipment from electric current, STBs with external power supplies never offer this feature.

For STBs using an external power supply, this will always be active and must have good energy efficiency characteristics. Power supply conversion efficiency at light load becomes important both in external and internal supplies.

3) RF front-end

The RF front-end / tuner is the base module of the STB and interfaces the RF modulated digital data arriving via the antenna, satellite dish or cable. Simple STBs with no additional features are equipped with one RF front-end. STBs with additional features, such as hard disk (HDD) recording may use two RF front-ends, one for the signals of the program actually monitored by the user and one to supply the hard disk recorder. The appeal of time shift recording using HDD STBs is driving up the use of two tuner designs.

The worldwide acceptance of DVB digital television broadcasting standards has enabled tuner module suppliers to manufacture in large production batches at high commercial viability. R&D support for the product is strong resulting in step improvements in RF performance and energy efficiency. Newly developed single chip tuners will gradually replace modular tuners with a commensurate benefit to production costs and material requirements.

4) MPEG Decoder Main Processor

The MPEG decoder is used to convert the compressed digital and audio data packets recovered from the RF demodulating and error-correcting process, into a format that can be converted to the required output signals for the connected TV and other audio and video equipment. The MPEG decoding is an integral part of the main processor activity and processor power requirement is very much affected by the design of the controlling software. Designers of “benchmark” energy efficient Simple STBs have shown that processor power can be reduced by more than 50% for a given MPEG decoding process by careful software design.

5) Front panel and IR receiver

The front panel and IR receiver electronics is located on a small PCB very close to the front plate. In some STBs with very low standby power requirements these electronics are integrated into a single chip with an auxiliary power supply and microprocessor.

6) Internal cabling

To reduce production costs internal cabling is kept to a minimum. If integration on one PCB is not possible, connection is realised via flatcable or flexible PCBs and connectors.

7) Remote controls

A typical remote control is made of a plastic material casing (ABS acrylonitrile, butadiene, styrol or PS polystyrene). It is equipped with a small PCB with an IR emitting diode and a small keypad covered with a thin silicone/rubber mat. For the power supply of the remote control two alkaline cells are common. Other power sources such as small manual generators, solar cells and fuel cells have been experimented with but have not proved acceptable to the user or commercially viable. [63]

[63]) One major Satellite Service Provider in Europe with a subscriber STB stock approaching 10 million units takes the issue of being responsible for the environmental impact of 20 million batteries, very seriously and is encouraging the development of alternative powering for remote controls.

8) Software

The software used in the Simple STB can have a critical influence on the power requirement both in standby and on-mode. Several examples of STBs with fast-shot low-cost software are recognised by their high energy demand, particularly in standby. Software control of the power distribution architecture, right down to functional block level in LSI chips is essential for effective power management.

4.3.2 Bill of Materials (BOM) for a Digital Terrestrial TV Simple STB

(Basic mid-cost primary reference product)

A typical mid cost small to medium form factor STB was selected for the reference BOM for this Task. The casing is plastic. This type of product currently dominates Simple STB sales in Europe.

No manufacturers' BOMs other than parts lists could be made available for this genre of product, even after several months of enquiry. The BOM and supporting data has been produced from the meticulous dismantling of several STB products down to component level. The weights of the constituent materials were measured directly. Where this was impossible (e.g. in the case of solder usage) Input from specialist manufacturers was sought.

The supporting data from other dismantled STB products provides a perspective on the differences in the BOM for steel cased medium to large form factor products with two tuners and HDD recording capability. These differences are identified in Table 4.3 below where the total use of materials is aggregated according to VHK eco-report requirements. Table 4.4 gives the full BOM for the primary reference product.

Life cycle Impact of Reference Simple STB and Additional Impact of Steel Case 2nd Tuner and HDD								
Life cycle phases →			**Production**			**End-of-Life**		
Resource use and Emissions			Material	Manuf.	Total	Disposal	Recycle	Total
Materials		**Unit**						
1	Bulk Plastics	**g**			425.5	382.9	42.6	425.5
2	Tec Plastics	**g**			33.0	28.9	4.1	33.0
3	Ferro	**g**			291.8	14.6	277.2	291.8
4	Non-Ferro	**g**			26.1	1.8	24.3	26.1
5	Coating	**g**						
6	Electronics	**g**			227.1	129.3	97.8	227.1
7	Misc	**g**			211.0	10.5	200.5	211
	Total Weight	**g**			1214.5	568.0	646.5	1214.5
Additional Impact of Steel Case , 2nd Tuner and HDD								
1	Bulk Plastics	**g**			- 152.0	- 136.8	- 15.2	
2	Tec Plastics	**g**			+ 48.0	+ 42.0	+ 6.0	
3	Ferro	**g**			+ 960.0	+ 48.0	+ 912	
4	Non-Ferro	**g**			+ 750.0		+ 697.5	
5	Coating	**g**						
6	Electronics	**g**			+ 50.0	+ 28.5	+ 21.5	
7	Misc	**g**			+233.0	+ 11.7	+ 221.3	
	Total Weight	**g**			+1889	- 6.6	+ 1843.1	

Table 4.3 Material Aggregation of Simple STBs

Table 4.1.3.2: Eco Report Input Table for Medium to Small Form Factor Simple STB (Plastic Housing)

Version 5 VHK for European Commission Nov.2005		Document Subject to a Legal Notice		
ECO- DESIGN of ENERGY –USING PRODUCTS		EuP EcoReport: INPUTS Assessment of Environmental Impact		
	Product Name Basic STB Terrestrial Digital Television		Date	Author
Pos	MATERIALS Extraction and Production	Weight grm.	Category	Material or Process
Nr.	Description of Component			
1	**Housing / Chassis**			
2	Casing Plastic Parts	326.0	1-Blk. Plastics	**10-ABS**
3	Chassis / Screening	285.0	3-Ferro	**21-Steel Sht. galv.**
4	Screws	1.7	3-Ferro	**25-Stainless 18/8 coil**
5	Rubber	4.0	2-Tecplastics	**16-Flex PUR**
6	**Electronic Boards**			
7	Electronic Module	18.0	6-Electronics	**44-Big caps &coils**
8	Electronic Module	28.0	6-Electronics	**45-Slots/Ext. Ports**
9	Electronic Module	9.5	6-Electronics	**46-ICs avg., 5% Si,Au**
10	Electronic Module	0.5	6-Electronics	**47-ICs avg., 1% Si**
11	Electronic Module	24.0	6-Electronics	**48-SMD/LEDs avg.**
12	Electronic Module	68.0	6-Electronics	**50-PWB 6 lay 4.5Kg/m2**
13	Electronic Module	0.6	6-Electronics	**52-Solder SnAg4Cu0.5**
14	**Remote Control**			
15	Casing	24.0	1-Blk. Plastics	**7-H1-PS**
16	Casing	35.0	1-Blk. Plastics	**10-ABS**
17	Rubber	13.8	2-Tecplastics	**16-Flex PUR**
18	Screws	1.2	3-Ferro	**25-Stainless 18/8 coil**
19	Contact Leaf/Spring	0.9	3-Ferro	**25-Stainless 18/8 coil**
20	Battery	15.0	6-Electronics	**44-Big caps &coils**
21	Electronic Module	2.0	6-Electronics	**44-Big caps &coils**
22	Electronic Module	1.0	6-Electronics	**45-Slots/Ext. Ports**
23	Electronic Module	0.6	6-Electronics	**46-ICs avg., 5% Si,Au**
24	Electronic Module	0.5	6-Electronics	**47-ICs avg., 1% Si**
25	Electronic Module	16.0	6-Electronics	**50-PWB 6 lay 4.5Kg/m2**
26	Electronic Module	0.2	6-Electronics	**52-Solder SnAg4Cu0.5**
27	**Power Supply (External 10W) Housing**			
28	Casing	12.5	1-Blk. Plastics	**10-ABS**
29	Casing	15.2	2-Tec. Plastics	**12-PC**
30	Casing Plug Pins	16.0	4-Non Ferro	**31-CuZn38 cast**
31	**Power Supply Electronic Board**			
32	Electronic Module	1.2	3-Ferro	**24-Ferrite**
33	Electronic Module	32	6-Electronics	**44-Big caps &coils**
34	Electronic Module	2.8	6-Electronics	**45-Slots/Ext. Ports**
35	Electronic Module	2.1	6-Electronics	**47-ICs avg., 1% Si**
36	Electronic Module	1.2	6-Electronics	**48-SMD/LEDs avg.**
37	Electronic Module	4.2	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
38	Electronic Module	0.7	6-Electronics	**52-Solder SnAg4Cu0.5**
39	Screws/Heatsinks	3.0	3-Ferro	**25-Stainless 18/8 coil**
40	Cables	11.0	4-Non Ferro	**29 Cu Wire**
41	Cables	24.0	1-Blk Plastics	**8-PVC**
42	**Packaging**			
43	Primary box/dividers	180.0	7-Misc	**56-Cardboard**
44	Plastic Bags	4.0	1-Blk Plastics	**1-LDPE**
45	Instruct. Manual/Leaflets	31	7-Misc	**57-Office Paper**

Table 4.4: Eco Report Input Table for Medium to Small Form Factor Simple STB (Plastic Housing)

4.4 Distribution phase (analysis of packaging)

Simple STB boxes currently have a wide range of packaging material. They are in general light and therefore do not suffer from the stringent packing requirements that exists for other video products, such as TV sets, which require significantly more mechanical shock protection.

Simple STBs equipped with an hard disk recorder will need more care concerning the selection of the packaging material since the hard disc drive is susceptible to damage from vibrations or mechanical shocks.

Many products sampled have already converted all their packaging to either cardboard or moulded cardboard pulp types. There is good scope for plastic and styrofoam to be almost eliminated from packaging for STBs. Table 4.5 shows the result of the packaging inspection of 6 STBs.

From these results a number of observations can be made. Firstly there seems to be no relationship between the weight of the packing and the weight of the STB. The heaviest unit 7.1 Kg (Philips) has packing that is comparable to other units weighing around 4 Kg. Also one of the units weighing 4.5 Kg (DG Tech) had packing that only weighed 0.8 Kg, which was a similar weight to the packaging for a Sony unit weighing 2.9 Kg.

Secondly, the choice of cushion also appears to have no relationship to the weight of the unit or whether it has a built in hard drive. Both of the Sony units that had Cardboard cushions weighed 4.0 Kg or more. The other units of similar weight used Expanded Polystyrene. The lightest unit, also a Sony, had plastic foam cushions, which clearly could have been cardboard.

From a logistics point of view the results are consistent with the proposition that this type of product does not need the cushioning properties of expanded polystyrene and the more echo friendly cardboard is a viable alternative.

From observation the heavier packing was due to the strength and corrugation properties of the cardboard. The heavier cardboards used contributed up to 30% of the weight of the packed STB. It seems likely that lighter cardboard would be suitable for most STBs, which would considerably reduce the transportation costs and associated environmental impacts.

STB Type	Dimensions	Packing	Packing Weight	STB Weight
SD Hard Drive	46cm x 51cm x 19cm	Cardboard Box Expanded Polystyrene Cushions Cellair Wrapping Plastic Bag	1.4 Kg	7.2 Kg
SD Hard Drive	45.5cm x 54cm x 17cm	Cardboard Box, Moulded Pulp Cardboard Cushions, Cellair Wrapping, Plastic Bag	2.1 Kg	4.5 Kg
SD Hard Disk Drive	39.5cm x 50.5cm x 13.5cm	Cardboard Box Expanded Polystyrene Cushions Plastic Wrapping	0.8 Kg	4.2 Kg
SD Disk Drive	42cm x 50.5cm x 13.5cm	Cardboard Box Cardboard Cushions Cellair Wrapping Plastic Bag	1.3 Kg	4.0 Kg
HD	35cm x 43.5cm x 13cm	Cardboard Box Plastic Foam Cushions Cellair Wrapping Plastic Bag	0.6 Kg	2.9 Kg
SD Hard Disk Drive	42cm x 50cm x 15cm	Cardboard Box Expanded Polystyrene Cushions Cellair Wrapping Plastic Bag	1.1 Kg	4.5 Kg

Table 4.5: Packing Material used for STBs

The sample is of course quite small and biased with HD and PVR product. Nevertheless it shows some inconsistency in the use of packaging materials that could be improved to reduce the environmental impact of material processing in manufacture and recycling.

4.5 Use phase (product)

In Europe, High Definition Services are just beginning to develop. Australia has had HD services since 2001 and was reported to have the highest STB take up for this type of service in the world. The energy use of such STBs will become important in the European market as these services are rolled out. A study of the energy use of several Australian HD STB receivers is shown in Fig 4.2.

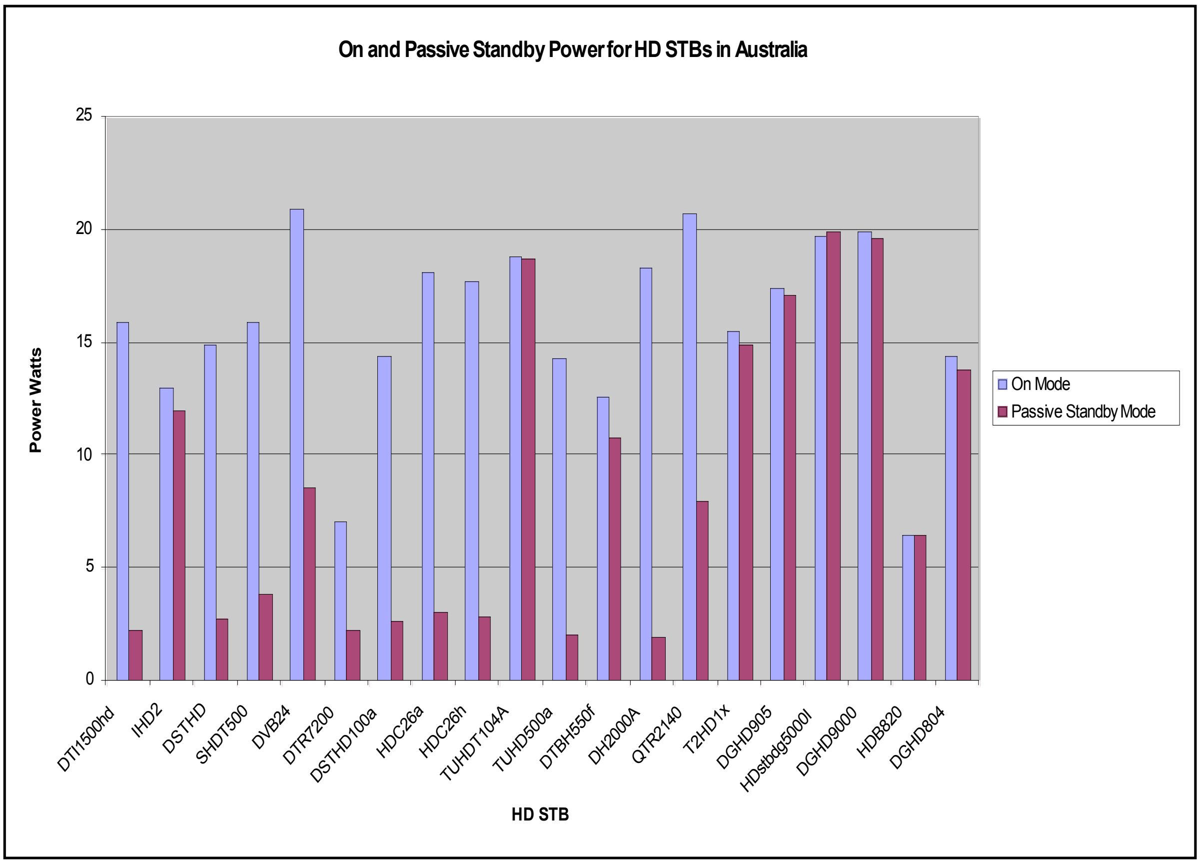

Fig 4.2: On phase Standby Power

The most recent Australian receiver to be analysed is based on an ST Microelectronics Chip Set 7100 and decodes MPEG4/ H264. This STB has a specified on - mode power of 12W and a passive standby of 3.5W. It is understood that software drivers are being developed that will achieve under 2 Watts passive standby. As many of the services that will be rolled out in Europe will be based on the MPEG4/H264 codec standard, these energy performance figures are very pertinent to this study.

4.6 Use phase (system)

Simple STBs have the potential to be unique in terms of a system consideration. At one end they potentially fall into the category of complex STBs, which are able to integrate into networks and share content throughout the interconnected and networked home and environment. At the other end they could be characterized by Simple USB and PCMCIA computer devices that enable TV to be watched on a PC.

In the future, but well within the analogue switch-off end point in Europe, a Simple STB could be a streaming device that receives and decodes TV broadcasts and then provides either a compressed or uncompressed (e.g. HDMI) stream that can be inserted into a home network (Wireless or Ethernet). This network would then make the stream available at different display devices around the home or indeed record the content for later viewing. In this way multiple Simple STBs within a home would become alternative signal sources for an integrated multimedia network without needing the individual complexity of a Complex STB that interacts at an advanced level with the network.

A variant on this, perhaps more relevant to the stock calculations for the Simple STBs that may be required to support switchover in Europe, is already used in multi apartment complexes. Each available service is received on a separate Simple STB. The video output of these STBs is then remodulated using an analogue scheme such as PAL into the distribution system for the multi unit dwelling. Each resident is then able to tune to these services using a standard analogue TV without the need and the energy implications of a STB. In Europe the problem of existing multi unit dwellings with inadequate cabling systems for digital TV is well understood. Schemes such as the ones outlined above are under consideration as part of the mix to solve these issues and achieve switch over.

The main competitors to the Simple STB are products that offer the same functionality but cross the definition boundary to Complex STB. DVD recording products with digital tuners and additional hard drive recording potential, though arguably a specific (different) product genre, are also competing product examples. Multimedia computers with built in tuners and as already identified, TVs with built in tuners (IDTVs) will all displace Simple STBs.

In the Free To Air (non-subscription) service mix STBs are usually purchased by the user so a price versus function argument will be present. Any consumer will have to see a significant price differential between the Simple STB with limited functionality and the product that offers a greater range of functions than just converting DTV signals. A DVD recorder is a good example of this as it may well be the DVD recording and playing features that appeals rather than the DTV tuner.

In a subscription environment the STBs are not normally purchased by the user but rented from the service provider. In these environments the problem of a Simple STB is more concentrated on the types of services that can be delivered. The competition between service providers means that consumers will be drawn to more elaborate services using Complex STBs with interactivity Video on Demand (VoD) etc. Again basic services using

Simple STBs at one price will attract "budget" customers others will migrate to more elaborate services with the associated more elaborate and complex STBs.

4.7 End-of-life phase

An important aspect of end of life phase is the proportion of the material used in the making of a STB that can be recycled, as opposed to the proportion that is waste and must be disposed of by land fill or other means. This has been covered by the BOM aggregation according to VHK shown in Table 4.3 in section 4.3.2 However the following table reflects current regimes of recycling.

Several comparable form factor Simple STBs were disassembled for this study and the component parts were assessed for potential re-use or recycling in the context of current regimes These differing parts were weighed and compared giving the following average results

Part	Description	Weight grams	Waste Category
Front Panel PCB	Paper PCB	52	Waste
Plastic Facia	Plastic	137	Recycle
Power Cord	Plastic/Copper	105	Re use/Recycle
Power Supply PCB		200	
	Aluminium	66	Recycle
	Transformers/Coils	47	Recycle
	Paper PCB & Other Components	87	Waste
Metal Rear Terminal Facia	Pressed Steel	149	Re Cycle
Decoder PCB	Paper PCB	500	Waste
External Metal Case	Pressed Steel	1450	Re Cycle
External Plastic Case	Plastic	550	Re Cycle
			Per Cent of Total
Total Weight (Steel case)		2593	
Total Recycle Weight		1954	75.36%
Total Waste Weight		639	24.64%

Table 4.3: Material used in Simple STBs

The most common medium to large form factor STB samples (low cost pacific rim source OEM) use a pressed steel case construction. This analysis shows that around 75% by weight of the STB can be recycled at the end of life. Fig 4.1 shows this graphically.

4.8 Conclusion Task 4

The technical analysis of existing products indicates that there are several key issues to be considered in the Tasks that follow.

The results of the tests on STBs conducted by Stiftung Warentest and others indicate that manufacturers and their electronic and industrial design specialists are becoming more aware of ecological issues. Concerning power consumption of STBs the market development is ambiguous.

There are some products that clearly show the possibilities of intelligent optimisation of the power consumption as well in On- as in Standby-mode. A bit irritating is the fact that even more or less unknown new brands glitter with very a low power consumption of their devices.

The main improvements to be considered are:

- Power efficiency of STB components from chip sets, to power supplies and hard disks (for PVR) in On- and Standby-mode
- Improvement of software design as it is relevant to energy consumption and power management.

5 Task 5: Definition of Base Cases

5.1 Introduction

This is the draft of the report on Task 5 “Definition of Base-Cases” for the EuP Preparatory studies on Simple STBs - Simple Digital TV Converters. We decided to focus on two different base cases:

c) Simple STBs as simple digital to analogue converter to use analogue TV equipment in the new digital world.

d) Simple STBs with hard disk or PVRs (Personal Video Recorders)

This is compatible to the definition in Task 1 where Simple STBs are defined as digital – analogue converters without conditional access (CA) function.

The decision to include PVRs without CA was made on the basis of the actual market developments. The price decline of hard disks will make the recording function an affordable feature.

5.2 Product-specific Inputs

To follow the actual development in Simple STB market there are two different products selected as base cases:

- Simple STB digital to analogue converter in a plastic box
- Simple STB with hard disk or PVR in a steel case cabinet

Both STBs are equipped with an external power supply. While the simple analogue to digital converter box is the actual low price entrance version for the mass market, the PVR Simple STB is the coming standard product that replaces the simple analogue to digital converters and the VHS cassette recorders the same time.

Data for the Base-Case On-Mode and Standby-Passive mode of the Simple STB products is drawn from the largest relevant market in the past three years – that of the UK. The data is assembled from independent testing done under the UK Government, Market Transformation Programme[64] and Digital TV Usability Action Plan Project[65] where available sales weighting has been used in the calculation of the Base–Case averages.

5.2.1 Base Cases: Simple STB

Replacing the steel case cabinet type of Simple STB the selected device in a plastic box is an example for the most recent development in Simple STBs. For the cabinet type basic STB this is the last version of their development history. The next step of electronic components integration will see the Scart sticks that are of the same size as Scart Cinch adapters. These tiny devices were displayed at the last IFA (Internationale Funkausstellung) in Berlin in 2007. Most of them were in their final prototype status. For this study were no examples for a closer analysis available.

Since the vast majority of Simple STBs are of the cabinet type the environmental impact of Simple STBs derives from such box versions.

64) www.mtprog.com
65) www.ricability-digitaltv.org.uk

Table 5.1: Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television

Nr	Life cycle Impact per product:	Date	Author
0	Simple STB Digital Terrestrial Television	04.10.07	ecostb.org

	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			**426**			383	43	**426**	**0**
2	TecPlastics	g			**33**			30	3	**33**	**0**
3	Ferro	g			**293**			15	278	**293**	**0**
4	Non-ferro	g			**27**			1	26	**27**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**227**			115	112	**227**	**0**
7	Misc.	g			**211**			11	200	**211**	**0**
	Total weight	g			**1216**			554	662	**1216**	**0**

Table 5.1: Base Case Simple STB (digital/analogue converter)

Since the expected life cycle for Simple STB is obviously limited to the transition period between the start of the digital broadcasting and about 5 years after the analogue switch off STB manufacturers are searching for new and additional market opportunities they could exploit to arise their field of business. Personal Video Recorders are such a product. The permanent price reduction for hard disk and the increasing capacity of these devices offer a new product group within the existing but fading market sector of VHS VCR (video cassette recorders) and DVD recorders. Depending on the video quality the size of the stored video file is different. Under the assumption of a video file size in best available standard quality (not HD) is not bigger than 5 GB using a 500 GB hard disk provides storage potential for about 100 videos or more than 50 hours of video. Since compression tools for video files are improving quite fast the storage capacity already available with existing hard disk technology will foster the market success of these hard disk driven easy to handle video recorders that give the consumers the chance to store videos without programming knowledge as it was needed for VHD VCRs. The absence of any consumables as cassettes or recordable DVDs with their standards problem will push this technology even further.

Table 5.2:Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television PVR

Nr	Life cycle Impact per product:	Date	Author
0	Simple STB Digital Terrestrial Television PVR	04.10.07	ecostb.org

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Mate rial	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**274**			246	27	**274**	**0**
2	TecPlastics	g			**81**			73	8	**81**	**0**
3	Ferro	g			**1253**			63	1190	**1253**	**0**
4	Non-ferro	g			**777**			39	738	**777**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**277**			140	137	**277**	**0**
7	Misc.	g			**444**			22	422	**444**	**0**
	Total weight	g			**3105**			583	2523	**3105**	**0**

Table 5.2: Base Case Simple STB / PVR with hard disk

With the time shift option offered by most PVR On-mode status and active Standby-mode gets more relevant since during the recording time the PVR is in On-mode. For the base case on Simple STBs with hard disk / PVR we made the assumption of 50 % On-mode and 50 % Standby-mode. Since booting time is relevant for PVRs no Off-mode phase could be expected.

5.3 Base-Case Environmental Impact Assessment

The industry was quite reluctant to provide essential data about Simple STBs. There may be different reasons for keeping the details of the devices hidden. The increasing integration of electronic components will be one of the reasons. With more and more know how about the STB technology shifting from the original STB manufacturers to chip developers and vendors of specialised modular components it is getting slightly easier to design new Simple STBs in less time with the experience in the STB design ordered with the modules from the vendor. A BOM (Bill of Material) of a Simple STB available for potential competitors would even lower the market entrance barrier for these new players and increase the already strong competition in this sector.

Finally the problem to source the product data could be reduced since a BOM as the terminus is used in the industry is by far different from the BOM according to the VHK terminology. Using a BOM as it is needed for the VHK EcoReport tool a potential competitor has no real access to the technological components needed as it is known to the public that a Simple STB consists of a box with electronic parts inside, an internal or external power supply and a battery powered remote control.

It could be helpful to communicate the VHK EcoReport tool and the data needed for this tool for the relevant industrial partners to make data sourcing significantly easier for the EuP Preparatory Studies scheduled. Finally all information relevant for the EcoReport could be sourced from different manufacturers.

One essential topic in parts responsible for the main environment related issue of Simple STBs the design of the software is in no way a part of the EcoReport tool that focuses on physical components and their interaction with the environment.

The influence of clever software design in energy demand of electronic devices is known from personal computers. It is obvious that software design gets more and more relevant to improve (reduce) the energy consumption of most electronic devices. Due to the short time and financial budget of this study on simple STBs it was not possible to check and quantify the influence of the respective software design on the energy consumption of the devices.

5.3.1 Base Case Simple STB

In the following the result of the environmental impact assessments for the Simple STB without PVR feature is displayed based on the results of the EcoReport tool of VHK. Since the higher integration of electronic components of Simple STBs leads to a significant reduction of the volume of resources needed for manufacturing the main target point of this assessment shifted from the manufacturing to the use phase of the product.

5.3.1.1 Overview of Assessment Results

Version 5 VHK for European Commission 28 Nov. 2005

Document subject to a legal notice (see below))

ECO-DESIGN OF ENERGY-USING PRODUCTS

EuP EcoReport: **RESULTS**
Assessment of Environmental Impact

Table 5.3 . Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television

Nr	Life cycle Impact per product:	Date	Author
0	Simple STB Digital Terrestrial Television	04.10.07	ecostb.org

	Life Cycle phases -->		PRODUCTION			DISTRI-BUTION	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**			Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**426**			383	43	**426**	**0**
2	TecPlastics	g			**33**			30	3	**33**	**0**
3	Ferro	g			**293**			15	278	**293**	**0**
4	Non-ferro	g			**27**			1	26	**27**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**227**			115	112	**227**	**0**
7	Misc.	g			**211**			11	200	**211**	**0**
	Total weight	g			**1216**			554	662	**1216**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	259	53	**311**	**56**	**2877**	40	42	**-2**	**3242**
9	of which, electricity (in primary MJ)	MJ	149	15	**164**	**0**	**2876**	0	13	**-13**	**3027**
10	Water (process)	ltr	132	3	**135**	**0**	**193**	0	12	**-12**	**316**
11	Water (cooling)	ltr	94	15	**108**	**0**	**7666**	0	3	**-3**	**7771**
12	Waste, non-haz./ landfill	g	1363	110	**1473**	**53**	**3347**	75	38	**36**	**4910**
13	Waste, hazardous/ incinerated	g	181	1	**181**	**1**	**68**	525	15	**510**	**760**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	14	3	**18**	**5**	**126**	3	3	**0**	**148**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	136	17	**153**	**13**	**742**	6	12	**-6**	**902**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**0**	**1**	0	0	**0**	**3**
18	Persistent Organic Pollutants (POP)	ng i-Teq	9	1	**10**	**0**	**19**	1	0	**0**	**30**
19	Heavy Metals	mg Ni eq.	27	2	**29**	**3**	**50**	11	2	**9**	**91**
	PAHs	mg Ni eq.	17	1	**18**	**3**	**6**	0	1	**-1**	**25**
20	Particulate Matter (PM, dust)	g	10	4	**15**	**2**	**16**	51	1	**51**	**83**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	58	0	**58**	**0**	**19**	3	7	**-4**	**74**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase**

Table 5.3: Environmental assessment results from VHK EcoReport for Simple STBs

In Table 5.3 the results from the environmental impact assessment for the Simple STB base case from the VHK EcoReport result table are displayed. Based on the details elaborated in Task 3 the daily use time of the Simple STB was assumed as 4 hours in On-mode and the remaining time of 20 hours per day in Standby–mode. The data resulting from this assumption are 1460 hours On-mode per year and 7300 hours in Standby–mode per year.

In Figure 5.1 the energy consumption in the different life cycle phases is displayed. It is not quite surprising the use phase of the Simple STB is the most energy consuming of all phases from production to recycling of the devices. These results are for a lifetime assumption for the devices of 5 years. As it is mentioned in the Tasks before the life of a Simple STB could be extended, if the box moves from the main TV to the children's room, the party room or the weekend home.

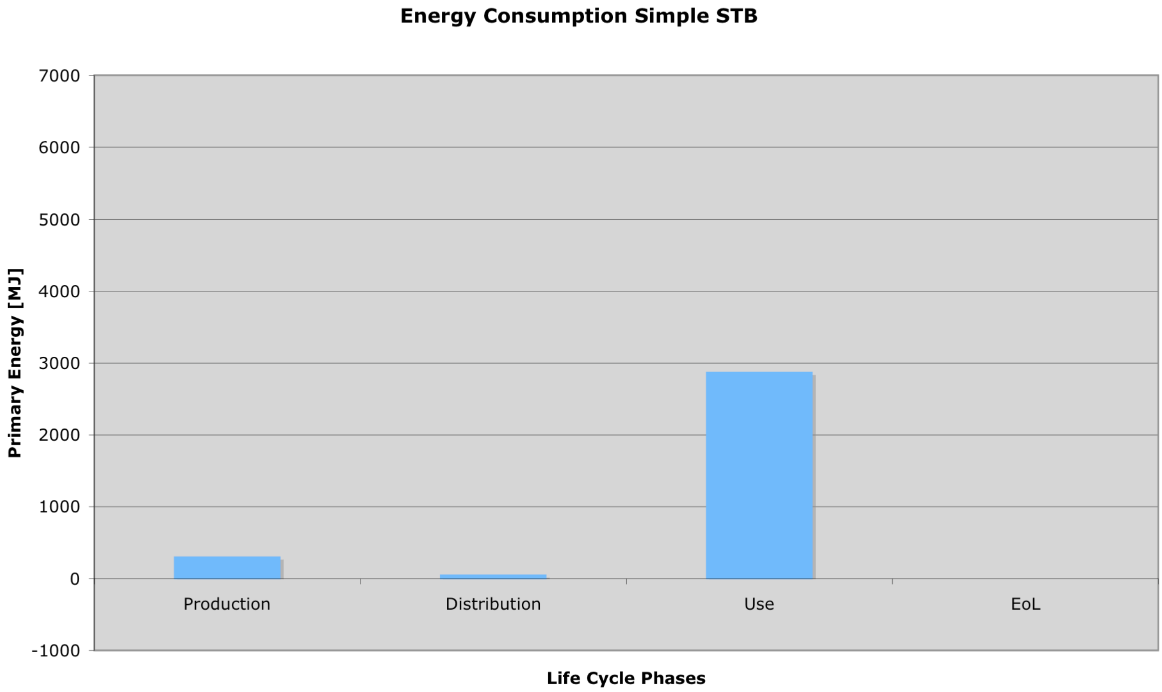

Figure 5.1: Energy consumption of Simple STBs in it's life cycle phases

5.3.1.2 Raw Material and Manufacturing (Production Phase)

A Simple STB ex factory comprises the packaging and three electric/electronic parts: The box itself (housing/chassis), the external power supply and the remote control. In Table 5.4 all material related specific environmental loads for all impacts and all parts are displayed. It is not surprising the main impact concerning hazardous waste derives from the PCB of the box and the remote control (See Task 6 and 7 for improvements concerning the reduction of hazardous waste.)

Version 5 VHK for European Commission 28 Nov. 2005

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ECO-DESIGN OF ENERGY-USING PRODUCTS

EuP EcoReport: RAW OUTPUTS Environmental Impact

Assessment of

Nr: 0 | Product: **Simple STB Digital Terrestrial Television** | Date: 04.10.07 | Author: ecostb.org

MATERIALS EXTRACTION & PRODUCTION

Product					Energy			Water		Waste		Emissions to Air							to Water	
nr	component	wght	cat.	material	GER	electr	feedst	(process)	water (cool)	haz. Waste	non-haz. Waste	GWP	AD	VOC	POP	HM	PAH	PM	Metal	EUP
		in g			MJ	MJ	MJ	ltr.	ltr.	g	g	kg CO2eq	g SO2eq	mg	ng i-Teq	mg Ni eq	mg Ni eq	g	mg Hg/20eq	mg PO4 eq
1	Housing /Chassis	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	Casing Plastic Parts	326	1-BlkPlastics	10-ABS	30,98	2,27	14,92	3,03	53,79	3,26	29,97	1,08	5,79	0,00	0,00	0,00	0,59	0,95	0,63	205,33
3	Chassis /Screening	285	3-Ferro	21-St sheet galv.	9,69	0,65	0,02	0,00	0,00	0,00	490,63	0,81	2,13	0,04	7,41	1,01	0,02	0,77	1,01	18,57
4	Screws	1,7	3-Ferro	25-Stainless 18/8 coil	0,11	0,02	0,01	0,13	0,01	0,00	1,70	0,01	0,10	0,00	0,01	0,25	0,00	0,01	0,15	3,96
5	Rubber	4	2-TecPlastics	16-Flex PUR	0,42	0,07	0,16	0,28	1,19	0,13	2,20	0,02	0,13	0,00	0,00	0,00	0,08	0,03	0,01	22,74
6	Electronic Boards	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	Electronic Module	18	6-Electronics	44-big caps & coils	6,90	0,00	0,00	0,62	0,99	0,35	10,81	0,39	2,55	0,00	0,04	0,14	3,68	0,64	1,34	0,13
8	Electronic Module	28	6-Electronics	45-slots / ext. ports	5,24	1,66	0,00	2,09	7,15	0,48	8,61	0,28	5,16	0,00	0,04	1,06	0,05	0,36	0,89	181,15
9	Electronic Module	9,5	6-Electronics	46-IC's avg., 5% Si, Au	52,34	50,90	0,00	47,66	0,00	2,39	49,22	4,02	26,48	0,64	0,46	4,24	0,14	0,69	35,53	204,07
10	Electronic Module	0,5	6-Electronics	47-IC's avg., 1% Si	0,44	0,34	0,00	0,31	0,05	0,32	0,87	0,03	0,41	0,00	0,00	0,09	0,00	0,01	0,00	2,15
11	Electronic Module	24	6-Electronics	48-SMD/ LED's avg.	71,25	69,25	0,00	22,21	0,00	3,14	67,94	4,01	38,89	0,18	0,36	10,12	0,11	1,22	0,35	52,69
12	Electronic Module	68	6-Electronics	50-PWB 6 lay 4.5 kg/m2	24,97	9,94	0,58	32,98	5,22	128,64	276,99	1,07	26,93	0,07	0,35	4,76	0,47	2,52	8,53	166,11
13	Electronic Module	0,6	6-Electronics	52-Solder SnAg4Cu0.5	0,14	0,12	0,00	0,04	0,00	0,00	0,14	0,01	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	Remote Control	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	Casing	24	1-BlkPlastics	7-HI-PS	2,21	0,11	1,18	0,13	4,46	0,02	0,72	0,07	0,47	0,00	0,00	0,00	1,46	0,04	0,00	1,43
16	Casing	35	1-BlkPlastics	10-ABS	3,33	0,24	1,60	0,33	5,78	0,35	3,22	0,12	0,62	0,00	0,00	0,00	0,06	0,10	0,07	22,04
17	Rubber	13,8	2-TecPlastics	16-Flex PUR	1,44	0,26	0,55	0,97	4,11	0,45	7,57	0,06	0,44	0,00	0,00	0,00	0,28	0,11	0,05	78,46
18	Screws	1,2	3-Ferro	25-Stainless 18/8 coil	0,07	0,01	0,00	0,09	0,01	0,00	1,20	0,01	0,07	0,00	0,01	0,18	0,00	0,01	0,10	2,79
19	Contact Leaf/Spring	0,9	3-Ferro	25-Stainless 18/8 coil	0,06	0,01	0,00	0,07	0,01	0,00	0,90	0,01	0,05	0,00	0,01	0,13	0,00	0,01	0,08	2,10
20	Battery	15	6-Electronics	44-big caps & coils	5,75	0,00	0,00	0,52	0,83	0,29	9,01	0,33	2,13	0,00	0,03	0,11	3,07	0,53	1,11	0,11
21	Electronic Module	2	6-Electronics	44-big caps & coils	0,77	0,00	0,00	0,07	0,11	0,04	1,20	0,04	0,28	0,00	0,00	0,02	0,41	0,07	0,15	0,01
22	Electronic Module	1	6-Electronics	45-slots / ext. ports	0,19	0,06	0,00	0,07	0,26	0,02	0,31	0,01	0,18	0,00	0,00	0,04	0,00	0,01	0,03	6,47
23	Electronic Module	0,6	6-Electronics	46-IC's avg., 5% Si, Au	3,31	3,22	0,00	3,01	0,00	0,15	3,11	0,25	1,67	0,04	0,03	0,27	0,01	0,04	2,24	12,89
24	Electronic Module	0,5	6-Electronics	47-IC's avg., 1% Si	0,44	0,34	0,00	0,31	0,05	0,32	0,87	0,03	0,41	0,00	0,00	0,09	0,00	0,01	0,00	2,15
25	Electronic Module	16	6-Electronics	50-PWB 6 lay 4.5 kg/m2	5,87	2,34	0,14	7,76	1,23	30,27	65,17	0,25	6,34	0,02	0,08	1,12	0,11	0,59	2,01	39,08
26	Electronic Module	0,2	6-Electronics	52-Solder SnAg4Cu0.5	0,05	0,04	0,00	0,01	0,00	0,00	0,05	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
27	PowerSupply (External 10 W) Housing	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
28	Casing	12,5	1-BlkPlastics	10-ABS	1,19	0,09	0,57	0,12	2,06	0,13	1,15	0,04	0,22	0,00	0,00	0,00	0,02	0,04	0,02	7,87
29	Casing	15,2	2-TecPlastics	12-PC	1,78	0,23	0,58	0,21	1,73	0,15	2,68	0,08	0,39	0,00	0,00	0,00	0,01	0,10	0,00	7,66
30	Casing Plug Pins	16	4-Non-ferro	31-CuZn38 cast	0,62	0,00	0,00	0,00	0,00	0,01	48,69	0,03	0,56	0,00	0,41	0,91	0,05	0,02	0,14	0,24
31	PowerSupply Electronic Board	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
32	Electronic Module	1,2	3-Ferro	24-Ferrite	0,06	0,00	0,00	0,05	0,00	0,00	3,10	0,01	0,01	0,00	0,05	0,04	0,00	0,00	0,00	0,09
33	Electronic Module	32	6-Electronics	44-big caps & coils	12,27	0,00	0,00	1,11	1,76	0,63	19,22	0,69	4,54	0,00	0,07	0,25	6,55	1,14	2,38	0,23
34	Electronic Module	2,8	6-Electronics	45-slots / ext. ports	0,52	0,17	0,00	0,21	0,72	0,05	0,86	0,03	0,52	0,00	0,00	0,11	0,01	0,04	0,09	18,12
35	Electronic Module	2,1	6-Electronics	47-IC's avg., 1% Si	1,84	1,41	0,01	1,28	0,22	1,35	3,67	0,12	1,71	0,00	0,02	0,39	0,01	0,05	0,02	9,02
36	Electronic Module	1,2	6-Electronics	48-SMD/ LED's avg.	3,56	3,46	0,00	1,11	0,00	0,16	3,40	0,20	1,94	0,01	0,02	0,51	0,01	0,06	0,02	2,63
37	Electronic Module	4,2	6-Electronics	49-PWB 1/2 lay 3.75kg/m2	1,18	0,63	0,04	0,71	0,32	7,28	11,03	0,05	0,90	0,01	0,01	0,15	0,01	0,02	0,06	15,48
38	Electronic Module	0,7	6-Electronics	52-Solder SnAg4Cu0.5	0,16	0,14	0,00	0,05	0,00	0,00	0,16	0,01	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00
39	Screws/Heatsinks	3	3-Ferro	25-Stainless 18/8 coil	0,19	0,03	0,01	0,23	0,03	0,00	3,00	0,02	0,17	0,00	0,02	0,44	0,00	0,02	0,26	6,98
40	Cables	11	4-Non-ferro	29-Cu wire	1,28	0,00	0,00	0,00	0,00	0,00	220,13	0,07	3,21	0,00	0,04	0,61	0,06	0,03	1,04	1,70
41	Cables	24	1-BlkPlastics	8-PVC	1,36	0,27	0,55	0,26	1,49	0,12	1,61	0,05	0,36	0,00	0,00	0,00	0,00	0,07	0,07	7,54
42	Packaging	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
43	Primary Box/Dividers	180	7-Misc.	56-Cardboard	5,04	0,36	2,88	1,27	0,00	0,01	9,42	0,13	0,19	0,00	0,00	0,01	0,00	0,00	0,00	15,49
44	Plastic Bags	4	1-BlkPlastics	1-LDPE	0,31	0,05	0,21	0,01	0,18	0,02	0,18	0,01	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,11
45	Instruct. Manual/Leaflets	31	7-Misc.	57-Office paper	1,24	0,19	0,84	2,36	0,00	0,01	2,09	0,02	0,16	0,01	0,00	0,00	0,00	0,05	0,00	163,94
	TOTAL	0	0	0	258,53	148,86	24,84	#####	93,75	180,53	1362,80	14,45	136,23	1,03	9,49	27,07	17,28	17,28	10,41	58,40

Table 5.4: Material related environmental impacts by categories (Simple STB)

5.3.1.3 Distribution, Use and End-of-Life Phase

As shown in Figure 5.1 the main environmental impact generated from Simple STBs is the energy consumption when the device is in it’s use phase.

Distribution is not relevant for significant environmental impacts due to the small size and weight of the product.

The use phase that is described by a use phase of 5 years has the most important environmental impact mainly depending on the On-mode (7300 hours for the whole expected product life of 5 years) and secondary to the Standby-mode (36500 hours for the whole expected product life of 5 years).

The primary energy consumption of the use phase is about 8 times higher than for manufacturing and distribution. So any improvement to reduce the environmental impact of Simple STBs has to target the power consumption during the use phase of the products.

As provided by the VHK EcoReport tool’s assessment the environmental impacts of the end-of-life / recycling phase is negligible.

Since most Simple STBs are not yet disposed after their use phase, but due to it’s tiny size stored in the cupboard as spare part for what issue ever simple STBs did not arrive in quantities for recycling.

According to the current WEEE directive the main target of Simple STB distributors/manufacturers is to reduce weight to reduce the respective fees. Thus they replace sheet metal casing that is easier to recycle by plastic material to reduce the weight.

5.3.2 Base Case Simple STB / PVR

5.3.2.1 Overview of Assessment Results

Version 5 VHK for European Commission 28 Nov. 2005 — Document subject to a legal notice (see below))

ECO-DESIGN OF ENERGY-USING PRODUCTS — EuP EcoReport: **RESULTS** Assessment of Environmental Impact

Table 5.5. Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television PVR

Nr	Life cycle Impact per product:	Date	Author
0	Simple STB Digital Terrestrial Television PVR	04.10.07	ecostb.org

Nr	Life Cycle phases -->		PRODUCTION			DISTRIBUTION	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total			Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**274**			246	27	**274**	**0**
2	TecPlastics	g			**81**			73	8	**81**	**0**
3	Ferro	g			**1253**			63	1190	**1253**	**0**
4	Non-ferro	g			**777**			39	738	**777**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**277**			140	137	**277**	**0**
7	Misc.	g			**444**			22	422	**444**	**0**
	Total weight	g			**3105**			583	2523	**3105**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	303	72	**375**	**94**	**5737**	42	44	**-2**	**6204**
9	of which, electricity (in primary MJ)	MJ	158	23	**181**	**0**	**5735**	0	16	**-16**	**5900**
10	Water (process)	ltr	159	4	**163**	**0**	**384**	0	14	**-14**	**532**
11	Water (cooling)	ltr	83	19	**102**	**0**	**15290**	0	4	**-4**	**15389**
12	Waste, non-haz./ landfill	g	3191	190	**3382**	**72**	**6681**	190	47	**144**	**10279**
13	Waste, hazardous/ incinerated	g	275	1	**276**	**1**	**135**	456	18	**438**	**850**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	18	4	**22**	**8**	**250**	3	3	**0**	**280**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	161	23	**184**	**23**	**1478**	6	14	**-8**	**1677**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**1**	**2**	0	0	**0**	**5**
18	Persistent Organic Pollutants (POP)	ng i-Teq	34	3	**38**	**0**	**38**	1	0	**1**	**77**
19	Heavy Metals	mg Ni eq.	33	8	**41**	**4**	**99**	11	2	**9**	**153**
	PAHs	mg Ni eq.	18	1	**19**	**3**	**11**	0	2	**-2**	**32**
20	Particulate Matter (PM, dust)	g	15	6	**20**	**14**	**32**	54	1	**53**	**118**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	68	0	**68**	**0**	**38**	3	9	**-6**	**100**
22	Eutrophication	g PO4	2	0	**2**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 5.5: Environmental assessment results from VHK EcoReport for Simple STB / PVR

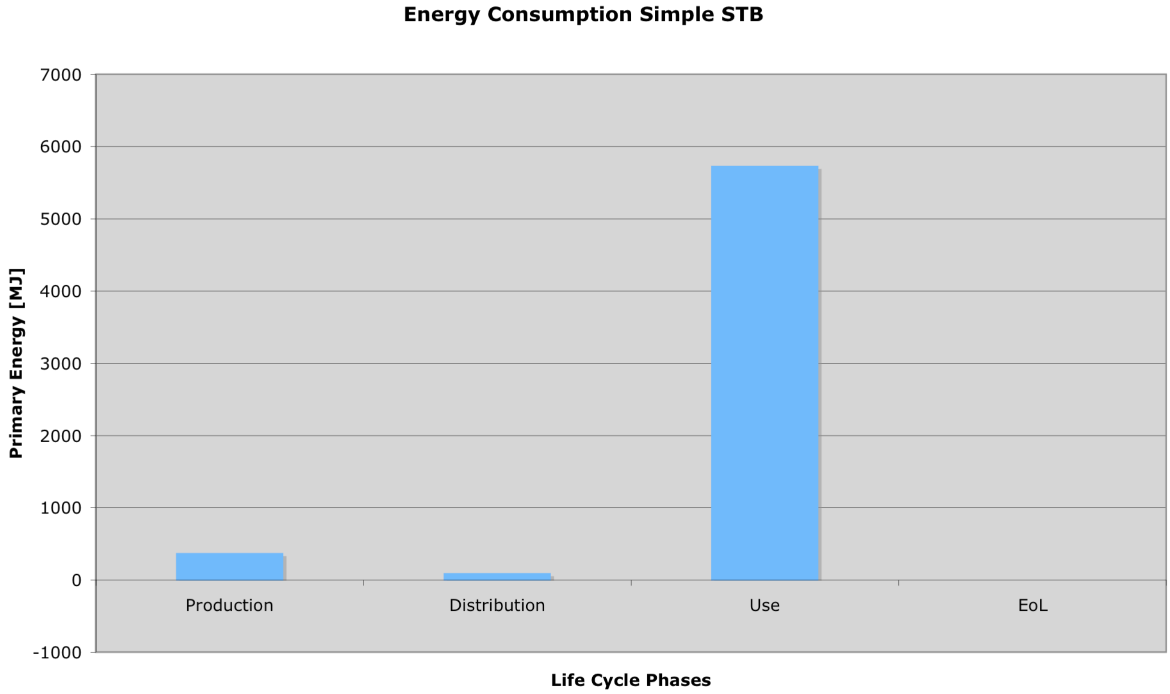

Figure 5.3: Energy consumption of Simple STB / PVR in it's life cycle phases

For Simple STB / PVR the energy consumption during the use phase is even more relevant compared with the production and distribution phase as it is for the simple STB without additional features. The main reason for this detail comes not only from the higher power consumption in On-mode but mainly it derives from the different frequency as it is assumed on the basis of the additional recording features a PVR offers. Time shift options need the same amount of recording time as the consumer needs for viewing the recorded broadcasts. Under the assumption of an average of 4 hours TV consumption in Europe we made the assumption, that another 4 hours per day the PVR is used for recording. The amount of time Standby-mode is cut respectively by these 4 hours.

5.3.2.2 Raw Material and Manufacturing (Production Phase)

The PVR type of Simple STBs is in it's early development stage. So at this stage with relatively small production lots, using metal cabinets is cheaper than casted plastic material. So it is not surprising that the amount of Ferro increases the Simple STB by 960 g and the Non-Ferro fraction is 750 g higher per piece. On the opposite site the bulk plastic fraction is significantly lower. The additional features as the hard disk is one reason for the higher amount of components, the other reason is the lower integration into silicon that is caused by the early development stage of this product group. The high amount of the Misc. Fraction is caused by the bigger and more rugged packaging.

Version 5 VHK for European Commission 28 Nov. 2005 | Document subject to a legal notice (see below)

ECO-DESIGN OF ENERGY-USING PRODUCTS | EuP EcoReport: RAW OUTPUTS | Assessment of Environmental Impact

Nr: 0 | Product: **Simple STB Digital Terrestrial Television PVR** | Date: 04.10.07 | Author: ecostb.org

MATERIALS EXTRACTION & PRODUCTION

Product					Energy			Water		Waste		Emissions to Air							to Water	
nr	component	wght	cat	material	GER	electr	feedst	water (process)	water (cool)	haz. Waste	non-haz. Waste	GWP	AD	VOC	POP	HM	PAH	PM	Metal	EUP
		in g			MJ	MJ	MJ	ltr.	ltr.	g	g	kg CO2eq	g SO2eq	mg	ng i-Teq	mg Ni eq	mg Ni eq	g	mg Hg/20 eq	mg PO4 eq
1	Housing / Chassis	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	Casing Plastic Parts	174	1-BlkPlastics	10-ABS	16,53	1,21	7,96	1,62	28,71	1,74	16,00	0,58	3,09	0,00	0,00	0,00	0,31	0,50	0,34	109,59
3	Chassis / Screening	1245	3-Ferro	21-St sheet galv.	42,33	2,84	0,09	0,00	0,00	0,00	2143,29	3,52	9,29	0,17	32,37	4,41	0,09	3,37	4,42	81,14
4	Screws	1,7	3-Ferro	25-Stainless 18/8 coil	0,11	0,02	0,01	0,13	0,01	0,00	1,70	0,01	0,10	0,00	0,01	0,25	0,00	0,01	0,15	3,96
5	Rubber	52	2-TecPlastics	16-Flex PUR	5,43	0,97	2,07	3,64	15,50	1,68	28,54	0,23	1,67	0,00	0,00	0,00	1,05	0,43	0,17	295,65
6	Electronic Boards	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	Electronic Module	18	6-Electronics	44-big caps & coils	6,90	0,00	0,00	0,62	0,99	0,35	10,81	0,39	2,55	0,00	0,04	0,14	3,68	0,64	1,34	0,13
8	Electronic Module	28	6-Electronics	45-slots / ext. ports	5,24	1,66	0,00	2,09	7,15	0,48	8,61	0,28	5,16	0,00	0,04	1,06	0,05	0,36	0,89	181,15
9	Electronic Module	9,5	6-Electronics	46-IC's avg., 5% Si, Au	52,34	50,90	0,00	47,66	0,00	2,39	49,22	4,02	26,48	0,64	0,46	4,24	0,14	0,69	35,53	204,07
10	Electronic Module	0,5	6-Electronics	47-IC's avg., 1% Si	0,44	0,34	0,00	0,31	0,05	0,32	0,87	0,03	0,41	0,00	0,00	0,09	0,00	0,01	0,00	2,15
11	Electronic Module	24	6-Electronics	48-SMD/ LED's avg.	71,25	69,25	0,00	22,21	0,00	3,14	67,94	4,01	38,89	0,18	0,36	10,12	0,11	1,22	0,35	52,69
12	Electronic Module	118	6-Electronics	50-PWB 6 lay 4.5 kg/m2	43,33	17,25	1,01	57,24	9,06	223,23	480,65	1,85	46,73	0,12	0,60	8,27	0,81	4,37	14,80	288,24
13	Electronic Module	0,6	6-Electronics	52-Solder SnAg4Cu0.5	0,14	0,12	0,00	0,04	0,00	0,00	0,14	0,01	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	Remote Control	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	Casing	24	1-BlkPlastics	7-HIPS	2,21	0,11	1,18	0,13	4,46	0,02	0,72	0,07	0,47	0,00	0,00	0,00	1,46	0,04	0,00	1,43
16	Casing	35	1-BlkPlastics	10-ABS	3,33	0,24	1,60	0,33	5,78	0,35	3,22	0,12	0,62	0,00	0,00	0,00	0,06	0,10	0,07	22,04
17	Rubber	13,8	2-TecPlastics	16-Flex PUR	1,44	0,26	0,55	0,97	4,11	0,45	7,57	0,06	0,44	0,00	0,00	0,00	0,28	0,11	0,05	78,46
18	Screws	1,2	3-Ferro	25-Stainless 18/8 coil	0,07	0,01	0,00	0,09	0,01	0,00	1,20	0,01	0,07	0,00	0,01	0,18	0,00	0,01	0,10	2,79
19	Contact Leaf Spring	0,9	3-Ferro	25-Stainless 18/8 coil	0,06	0,01	0,00	0,07	0,01	0,00	0,90	0,01	0,05	0,00	0,01	0,13	0,00	0,01	0,08	2,10
20	Battery	15	6-Electronics	44-big caps & coils	5,75	0,00	0,00	0,52	0,83	0,29	9,01	0,33	2,13	0,00	0,03	0,11	3,07	0,53	1,11	0,11
21	Electronic Module	2	6-Electronics	44-big caps & coils	0,77	0,00	0,00	0,07	0,11	0,04	1,20	0,04	0,28	0,00	0,00	0,02	0,41	0,07	0,15	0,01
22	Electronic Module	1	6-Electronics	45-slots / ext. ports	0,19	0,06	0,00	0,07	0,26	0,02	0,31	0,01	0,18	0,00	0,00	0,04	0,00	0,01	0,03	6,47
23	Electronic Module	0,6	6-Electronics	46-IC's avg., 5% Si, Au	3,31	3,22	0,00	3,01	0,00	0,15	3,11	0,25	1,67	0,04	0,03	0,27	0,01	0,04	2,24	12,89
24	Electronic Module	0,5	6-Electronics	47-IC's avg., 1% Si	0,44	0,34	0,00	0,31	0,05	0,32	0,87	0,03	0,41	0,00	0,00	0,09	0,00	0,01	0,00	2,15
25	Electronic Module	16	6-Electronics	50-PWB 6 lay 4.5 kg/m2	5,87	2,34	0,14	7,76	1,23	30,27	65,17	0,25	6,34	0,02	0,08	1,12	0,11	0,59	2,01	39,08
26	Electronic Module	0,2	6-Electronics	52-Solder SnAg4Cu0.5	0,05	0,04	0,00	0,01	0,00	0,00	0,05	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
27	PowerSupply (External 10 W) Housing	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
28	Casing	12,5	1-BlkPlastics	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
29	Casing	15,2	2-TecPlastics	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
30	Casing Plug Pins	766	4-Non-ferro	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
31	PowerSupply Electronic Board	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
32	Electronic Module	1,2	3-Ferro	24-Ferrite	0,06	0,00	0,00	0,05	0,00	0,00	3,10	0,01	0,01	0,00	0,05	0,04	0,00	0,00	0,00	0,09
33	Electronic Module	32	6-Electronics	44-big caps & coils	12,27	0,00	0,00	1,11	1,76	0,63	19,22	0,69	4,54	0,00	0,07	0,25	6,55	1,14	2,38	0,23
34	Electronic Module	2,8	6-Electronics	45-slots / ext. ports	0,52	0,17	0,00	0,21	0,72	0,05	0,86	0,03	0,52	0,00	0,00	0,11	0,01	0,04	0,09	18,12
35	Electronic Module	2,1	6-Electronics	47-IC's avg., 1% Si	1,84	1,41	0,01	1,28	0,22	1,35	3,67	0,12	1,71	0,00	0,02	0,39	0,01	0,05	0,02	9,02
36	Electronic Module	1,2	6-Electronics	48-SMD/ LED's avg.	3,56	3,46	0,00	1,11	0,00	0,16	3,40	0,20	1,94	0,01	0,02	0,51	0,01	0,06	0,02	2,63
37	Electronic Module	4,2	6-Electronics	49-PWB 1/2 lay 3.75kg/m2	1,18	0,63	0,04	0,71	0,32	7,28	11,03	0,05	0,90	0,01	0,01	0,15	0,01	0,02	0,06	15,48
38	Electronic Module	0,7	6-Electronics	52-Solder SnAg4Cu0.5	0,16	0,14	0,00	0,05	0,00	0,00	0,16	0,01	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00
39	Screws/Heatsinks	3	3-Ferro	25-Stainless 18/8 coil	0,19	0,03	0,01	0,23	0,03	0,00	3,00	0,02	0,17	0,00	0,02	0,44	0,00	0,02	0,26	6,98
40	Cables	11	4-Non-ferro	29-Cu wire	1,28	0,00	0,00	0,00	0,00	0,00	220,13	0,07	3,21	0,00	0,04	0,61	0,06	0,03	1,04	1,70
41	Cables	24	1-BlkPlastics	8-PVC	1,36	0,27	0,55	0,26	1,49	0,12	1,61	0,05	0,36	0,00	0,00	0,00	0,00	0,07	0,07	7,54
42	Packaging	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
43	Primary Box/Dividers	413	7-Misc.	56-Cardboard	11,56	0,83	6,61	2,91	0,00	0,02	21,61	0,29	0,43	0,00	0,01	0,01	0,00	0,00	0,01	35,54
44	Plastic Bags	4	1-BlkPlastics	1-LDPE	0,31	0,05	0,21	0,01	0,18	0,02	0,18	0,01	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,11
45	Instruct. Manual/Leaflets	31	7-Misc.	57-Office paper	1,24	0,19	0,84	2,36	0,00	0,01	2,09	0,02	0,16	0,01	0,00	0,00	0,00	0,05	0,00	163,94
200	0	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	0	0	0	0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	TOTAL	0	0	0	303,05	158,35	22,87	159,19	83,02	274,88	3191,16	17,67	161,11	1,21	34,30	33,07	18,30	18,30	14,66	67,77

Table 5.6: Material related environmental impacts by categories (Simple STB / PVR)

5.3.2.3 Distribution, Use and End-of-life Phase

As it is visible from Figure 5.3 the main environmental impact of the energy consumption during the use phase is eve more significant than with the Simple STBs without the recording feature. The expected lifetime for PVRs is assumed with 5 years as this is the commonly assumed lifetime of personal computers. Since most of the additional components as there is the hard disk are an offspring of the personal computer technology, this should be a reasonable assumption.

5.3.4 Conclusion

The review of the different phases of the product life of both Simple STBs base cases indicate quite clearly that the main environmental impact of the Set top boxes is given by the power consumption during the use phase of the devices.

On the basis of the VHK EcoReport tool’s assessments reducing the power consumption would be the main adjusting screw for any reduction of the environmental impact of Simple STBs with or without recording features.

5.4 Base-Case Life Cycle Costs

5.4.1 Input Data for LCC Analysis

For the live cycle cost calculation (LCC) for total EU-25 for the year 2005 the following data are required:

EU-25 market / stock data for the household penetration of Simple STBs in 2005 (.000 units)

EU-25 annual sale of Simple STBs in 2005 (.000 units)

Average sales price for Simple STB (in €)

Average repair and maintenance cost (in €)

Average electricity rates (in Euro Cent/kWh)

Average lifetime of a product (in years)

Average annual power consumption including On-mode and Standby-mode (in kWh)

In the following the selection of the input data is explained.

5.4.1.1 Market Data Aggregation

Since the Simple STB market segment is developing very fast due to the analogue switch off in several regions we decided not to use the stock data from 2005 but the estimations for the stock data of 2007. The stock data for the year 2007 are taken from the estimations in Task 2. The same procedure is used for the sales data.

For Simple STBs/PVRs the basic assumption (based on the poll data in Task 3) for 2007 is a stock and sales volume that is about 6 % of the Simple STB volume.

	Stock Data	Sales Data
	20007	2007
Simple STB	47.000	12.300
Simple STB/PVR	2.820	738

Table 5.7: Stock and sales data for Simple STBs and Simple STBs/PVRs (in 1000 units)

5.4.1.2 Costs/Price Data Aggregation

The average sales price of a Simple STB is about Euro 50,00.

The average sales price of Simple STB/PVR is about Euro 150,00.

Prices are decreasing very fast. Due to licensing and handling costs the lowest price target of a Simple STB is about Euro 30,00. Due to the fierce competition in this market segment the STB manufacturers will prefer to add additional features instead of lowering the price. The continuously higher integration of silicon component will ease this development. Any repair cost are omitted due to the absence of any repair facility for Simple STBs. Repair cost would be significantly higher than the price of a product replacement. For Simple STBs/PVRs the assumption is made that replacement will beat repair costs as well. So repair costs are not included into the LCC analysis.

5.4.1.3 Power Consumption Data and Electricity Rates

For the power consumption of the Set Top Boxes the following assumptions are made from the product data available and the data from Task 3. The average price per kWh in Europe is 0,14 Euro per kWh.

	Simple STB	Simple STB/PVR	
Power consumption (kW)			
On-mode	0,0070	0,0256	
Standby-mode	0,0061	0,0059	
Working hours per day (h)			
On-mode	4	4	8
Standby-mode	20	20	16
Annual power consumption (kWh)	54,75	80,44	109,20

Table 5.8: Power consumption for the Simple STB base cases

5.4.2 LCC Analysis

The result of the life cycle cost analysis for the two base cases of Simple STBs are displayed in the following tables. Due to the fast market development the LCC is calculated for the year 2007.

LCC Analysis for Simple STB

The following Table 5.7 and 5.8 show the results of the VHK EcoReport LCC assessment for the two Simple STBs base cases.

Table 5.9: Life Cycle Costs per product and Total annual expenditure (2007) in the EU-25

	Simple STB Digital Terrestrial Television	LCC new product		total annual consumer expenditure in EU25	
D	Product price	50	€	615	mln.€
F	Electricity	33	€	360	mln.€
	Total	**83**	€	**975**	mln.€

Table 5.9: Life cycle costs Simple STB

LCC Analysis for Simple STB / PVR with hard disk

Table 5.10: Life Cycle Costs per product and Total annual expenditure (2007) in the EU-25

	Simple STB Digital Terrestrial Television PVR	LCC new product		total annual consumer expenditure in EU25	
D	Product price	150	€	111	mln.€
F	Electricity	49	€	32	mln.€
	Total	**199**	€	**142**	mln.€

Table 5.10: Life cycle costs Simple STB + Hard disk (4 hours On-mode per day)

Table 5.11: Life Cycle Costs per product and Total annual expenditure (2007) in the EU-25

	Simple STB Digital Terrestrial Television PVR	LCC new product		total annual consumer expenditure in EU25	
D	Product price	150	€	111	mln.€
F	Electricity	66	€	43	mln.€
	Total	**216**	€	**154**	mln.€

Table 5.11: Life cycle costs Simple STB + Hard disk

5.4.3 Conclusion

The life cycle cost analysis of the two Simple STB base cases display the situation slightly different as is recognised by the consumer. The main cost within the product lifetime is in both cases the price for the product. For the Simple STB without any extra feature the LCC for a new product indicates that 40 % of the annual expenditure is given by the costs power consumption (electricity). The longer the actual use phase becomes due to secondary use the more relevant becomes the fee for the electricity.

For Simple STBs / PVRs the ratio between product price and electricity costs is better only due to higher cost of the product.

5.5 EU Totals

5.5.1 Simple STB annual power consumption assessment

For some years power consumption of Simple STBs was not a main target of the majority of STB manufacturers. The main goals were to follow up the technological development and to stay competitive in the rapidly growing market. Higher integration of the applied silicon and improvement of the software needed to speed up booting time were even closer to the focus than energy consumption. At IFA (Internationale Funkausstellung) 2007 in Berlin a few manufacturers started to display a low power demand of their new products. Unfortunately the STBs with the lowest power demand in Standby-mode were Complex STBs. For Simple STBs the main improvement visible was a hard mains switch on the front plate of the device. Nevertheless most manufacturers stated they could reduce the power consumption of their respective device, if there is any legal framework that urges all distributors to do so.

For this study we took the two base cases from product examples that are of the actual manufacturing line. Since most of the STBs in the development stage are equipped with external power supplies the tendency described in the respective study about ESPs is somehow relevant for the future Simple STBs. Other improvement potentials are reviewed in the following tasks.

The data basis for the on-mode power consumption calculation is given by the two selected base cases.

	Simple STB	Simple STB/PVR
Power consumption (kW)		
On-mode	0,0070	0,0256
Working hours per day (h)		
On-mode	4	8

Table 5.12: Power consumption of base case Simple STBs in On-mode

	Simple STB	Simple STB/PVR
Power consumption (kW)		
Standby-mode	0,0061	0,0059
Hours per day (h)		
Standby-mode	20	16

Table 5.13: Power consumption of base case Simple STBs in Standby-mode

	Simple STB	Simple STB/PVR
Annual power consumption per device (kWh)	54,75	108,976
EU-25 stock of STBs in 2007 in mln	47	2,82
EU-25 annual consumption of STBs (MWh)	2573,250	307,312

Table 5.14: Power consumption scenario for the two Simple STB base cases

5.5.2 Conclusion

Since the EU-25 stock of Simple STBs is estimated to grow to an amount of about 177 million devices with an increasing share of PVRs it is obvious that a reduction of the power demand of Simple STBs is essential to reduce the environmental impact of these devices.

The starting integration of digital receivers into TV sets could reduce the environmental burden given by the double number of receivers: the tradition analogue receiver in the TV set and the additional STB as digital to analogue converter.

This development would be nullified with the next technological innovation step in digital broadcasting. Since new broadcasting technology would be faster developed than the existing stock of TV equipment could be changed there will be a significant market share for STBs to convert from the respective new broadcasting technology to the available TV equipment.

With this perspective it is essential to start to reduce the power demand of STBs immediately. A further option could be to separate any receiver from the TV set and provide receiver-less monitors to be completed by a STB. This could be a solution to avoid obsolete integrated TV receivers using outdated technology.

6 Task 6: Technical Analysis BAT

6.1 Introduction

Task 6 is based on interviews with several stakeholders on new technologies relevant for Simple STBs. Information used for Task 6 was provided by different sources. Intellectual property, technical feasibility and availability of the technologies on the market are not judged as it is the purpose of this task to illustrate different technologies promoted by their manufacturers as an improvement for Simple STBs. However, specific products from manufacturers are mentioned in the report as examples of technologies available. Products and technologies mentioned in Task 6 are not limited to Simple STBs and their implementation could be even more interesting in other fields of consumer or professional electronics.

6.2 Power management

When the set top box is not required for decoding digital television the user is encouraged to put it into "STANDBY". For many users this mode could apply for almost 80% of the time and it is here that most energy saving potential could be located. However, ease of use requirements often determine what is meant by standby. With the massive bouquets of programmes available in digital broadcasting, Electronic Programme Guides (EPG) became essential and their update requires a STB activity that is not necessarily obvious to the user and that may occur when the user has left the STB in standby. Listed below are three potential operational modes with an overview of the BAT approach to their implementation

Standby-passive

In this state, the set top box will have minimal functionality. In most designs featuring very low standby levels (<1W) most circuit blocks, the processor and the software may be inactive, signal feed through (Baseband and RF) may be disabled. All that is needed is the ability to receive and recognise an IR user command to switch the STB into the active state. This is usually achieved, with a low power MCU (Micro Control Unit) integrating a small amount of ROM a microprocessor and IR detection as well as a power supply. These devices are becoming more competitively priced and are incorporated in new low cost STB designs.

This standby mode can be used for those broadcast services where there is no requirement for continuous or time dependant communication. It offers the greatest opportunity for energy saving but does require time for software initialisation when coming out of standby.

An alternative approach is to use the main processor of the STB running at a very low clock rate and some of the main memory. The STB is not receiving any signal but some software is running and timed or triggered wake-up is possible as well as rapid response to a user command. The set top box may periodically wake-up to check the data stream for anything addressed to it and update the EPG (Electronic Programme Guide) Another approach is the use of a software suspend mode where all processing (except possibly a timer) is halted but memory self-refresh is used to enable rapid wake-up.

Figure 6.1 shows a simplified block diagram of a typical set top box. Some of the opportunities for power management of these circuit blocks in relation to operational and standby states are reviewed. The blocks consuming the majority of the power are the main processor, MPEG decoder (often part of the main processor) RF front-end and the power supply / power distribution itself.

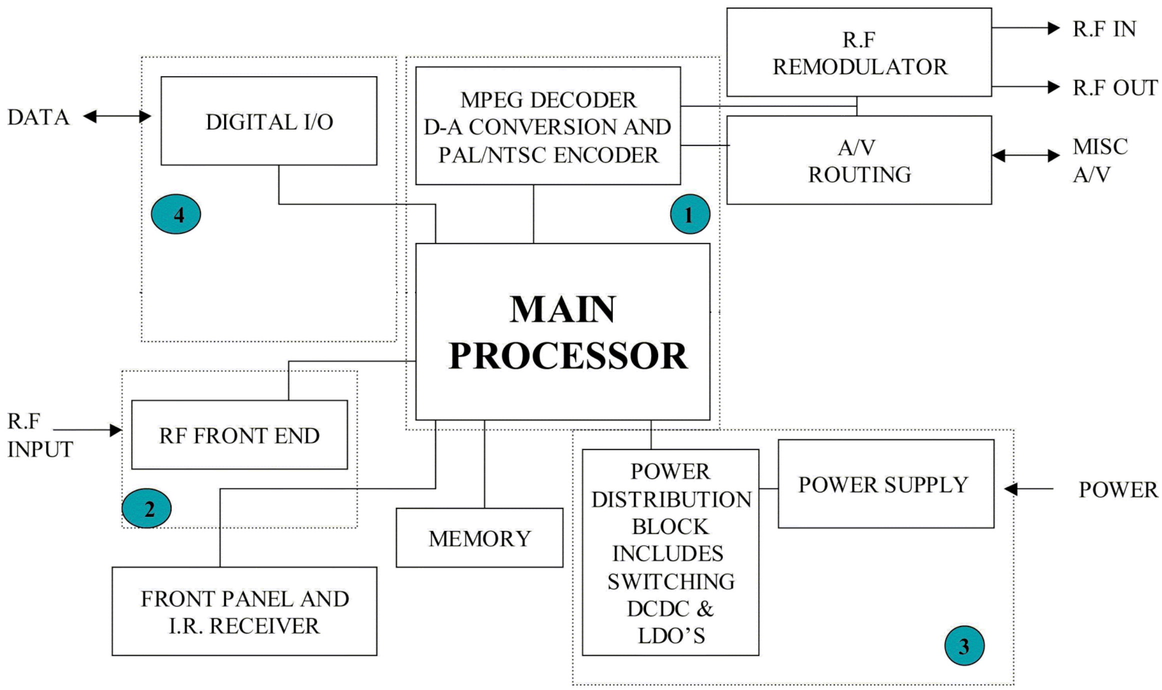

Figure 6.1: Block diagram of a STB

Block 1 MPEG Decoder Main Processor

In standby no TV picture is required so the MPEG decoder (along with D-A conversion and composite video encoding) can be disabled to reduce power consumption. Increasingly, this MPEG decoding to output streaming (digital and analogue output interfaces) is an integral part of the main processor. The simplest way to reduce power, with some software still active, is to lower the clock speed consistent with the level of processing needed. Ideally, clock management should be part of the processor design so that this can happen in a controlled manner without interruption of the residual software processes. The choice of software architecture can also have significant impact on energy consumption.

Block 2 RF front-end

In the Standby-passive state the RF front-end can be disabled or put into sleep mode. This also applies to two or more RF Tuners in STBs with integral storage. Where the STB automatically (on a memory/timer function) comes out of standby to download data (e.g. to update an EPG) it may be possible to reduce clock frequency to save power if processing data with a low symbol rate. Only one RF front end need be powered for this activity and all output interface processing inhibited.

Block 3 Power supply and power distribution

In the standby state, where there is no self powered MCU an internal power supply will still be active. For STBs using an external power supply, this will always be active and must have good energy efficiency characteristics at

For the Standby-passive, power could be removed from many circuit blocks just leaving a small circuit active to decode user commands from infra-red remote control or the front panel. Power supply conversion efficiency at light load then becomes important both in external and internal supplies.

Block 4 Digital I/O and Modem

Where required these circuits may be idle for much of the time, even when the rest of the STB is fully active. Similar techniques to those used in portable PC design would enable these functions to be normally in a low power state but still looking for any signal which requires them to become fully active.

Hard Disk Drive

The majority of simple STBs with a programme storage capability currently use a hard disc drive (HDD) to store the MPEG data stream for later viewing or time delayed viewing (live pause) The HDD may consume 6 watts of DC power when active. Careful management of the HDD can allow it to go into a sleep mode when not required. But a user requirement of almost instant recording and live pause often complicates the extent to which HDD activity can be inhibited. Smaller, lower power hard discs developed for the portable PC market are now being considered to reduce energy as massive pressure on notebook PC costs continue to drive down the cost of the HDD component. A parallel solution not yet seen in the market but firmly in the design stage is the use of medium capacity HD cards for the live pause /instant record short duration buffer. This is backed up by the HDD for longer term recording. High capacity HD cards are predicted to replace HDDs in some low cost simple STBs in less than five years and well within the analogue to digital switch over transition period in EU25.

Design Approaches For Maximum Energy Efficiency in an STB

Ideally adequate power management of each circuit block should be achieved by software control of the silicon. Switching of power rails may be needed but prompts careful scenario analysis of the user experience.

The designer must consider power consumption and in-built power management features when choosing silicon for the main processor and RF front-end. The software designers must be involved from the outset so that energy efficient software architecture and power management are fundamentals of the early design concepts. Third-party (licensed) software, which may be used for the operating system (or conditional access) must support power management.

The choice of RISC (Reduced Instruction Set Computer) CPU over a CISC (Complex Instruction Set Computer) CPU can help reduce the overall power consumption.

In the initial design stages, the designer should assemble a comprehensive power budget from the voltage and current requirements of each circuit block. The voltages delivered by the power supply should then be rationalised to allow a design giving minimum power loss in any post-regulation circuits.

The designer should ensure that power to peripheral ports and devices can be turned off when not required ideally as an automatic action transparent to the user. In the analogue to digital TV transition period, the user is likely to continue to use the TV remote control as well as the STB remote control. The likelihood is that the STB will be left on when the TV is switched to standby. Careful design consideration should be given to this issue. An ideal solution in the early transition phase is to incorporate automatic standby in the STB.

At the point in transition where STBs are being used solely for Digital TV reception remote control solutions must be considered allowing the user to put the STB and TV into standby simultaneously. The introduction of new silicon functional blocks is the key tool for achieving STB efficiency. Power management units come into this category.

Power Management Units (PMU's)

A Power Management Unit (PMU) is an up-integration into a single piece of silicon of the peripheral functions outside of the Main Processor & Power Blocks (see Figure 6.1) to allow the Main Processor to access a range of peripheral functions using only one control line. This means that the peripheral functions share a common interface with the Main Processor. So, Main Processor power management control can be implemented cost effectively.

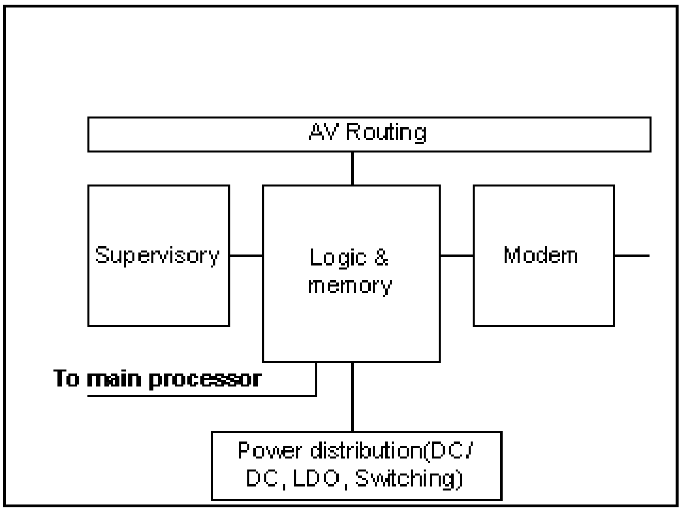

Figure 6.2: Block diagram of a PMU

Common benefits of PMU's within both major blocks are:

- The direct interconnection of blocks to the Main Processor allowing the Main Processor to readily put those blocks to "sleep" as and when needed.
- Serial addressing of the Main Processor and function blocks leads to simplification in layout, cost, and placement.
- Implementation of functions in software reduces hardware cost and power consumption.

Two physical locations in a STB can be defined as being suitable for a PMU implementation. These are the Front-Panel and the Main-Board.

Front-Panel PMU

Included within the general functionality of the Front-panel are the interfaces for display, IR, and keypad as well as the power distribution block. In particular the serial control that the Main Processor can exercise over the dimming functions of the display can yield power reduction savings. (In addition the smart card can be put into a sleep mode)

Main-Board PMU

Functions commonly included within the Main-board hardware are Audio-Visual routing such as SCART and HDMI interface. Power distribution within the Main-board can generate a substantial amount of "wasted" power. Power savings could be achieved using sleep modes or by cycle skipping (Burst Modes) of operation.

6.3 Miniaturization and System Integration (one chip solution)

The increasing pressure to reduce manufacturing cost of Simple STBs leads to higher system integration and miniaturization of these devices.

Single-chip RF front-end

One option for higher integration is offered by Silicon Laboratories (SiRX) with their product family of RF front-end ICs for DVB-S receivers. The single-chip implementation of the complete RF satellite front-end, consists of tuner, demodulator, LNB signalling controller and LNB supply regulator. The single-chip RF front-ends can simplify RF and power design for STBs. [66]

On the basis of the common bit stream syntax of an MPEG-2 transport stream (TS) in DVB-compliant satellite, cable, terrestrial a common platform approach is possible to reduce development and manufacturing costs due to economies of scale. The possible result is one single MPEG decoder/host IC across receivers for different access media. A single chip front-end dependent on the targeted medium (cable, terrestrial, satellite) then provides the TS input to the host. Using higher integrated silicon the target to reduce manufacturing costs is linked to the reduction of additional discrete components.

A disadvantage of higher chip integration is higher heat issues potential resulting in a thermally enhanced package design and an exposed heat pad.

A further example of reduced power requirements by integrating the terrestrial demodulator and a MPEG decoder in one package is offered by STMicrolectronics. The DTTi5516 is an integrated demodulator/decoder solution for digital terrestrial receivers for compressed video, sound and data services.

Another product already available to the market is *Texas Instruments*' DaVinci Silicon application for Simple Digital Television STBs. The product is now in use by a large Chinese manufacturer for IPTV platforms and will shortly move to other DTV platforms including Cable and Terrestrial STB.

The TI path of the current DaVinci family includes a mixture of hardware accelerators and programmable DSP resources. It is focussed on SD decode of H.264 (High Definition) and MPEG2.

[66]) In the past OEMs were shielded from the details of the satellite RF front-end design by using dedicated RF modules. The target of STB manufacturers to reduce production costs, and the availability of more integrated silicon tuners, now provides this function on the main board and therefore eliminates the former “canned” RF module. Due to the extremely competitive environment for manufacturers they target on value-added features, such as personal video recorder capability, interactivity, home networking extensions. Therefore OEMs try to buy a solution for the RF front-end that reduces their research and development cost but offers the required receiver performance standards.

The standby and active power consumption of a Simple STB equipped with the DaVinci solution depends on the architecture of the rest of the box, but active power should be between 500mW (MPEG2) and 900mW (H.264) for the processor with 200mW for the memory. The active standby power should be around 300mW for the processor and 80mW for the memory. The passive standby power should be around 90mW for the processor and 15mW for the memory. The off power should be around 15mW just for the memory to support fast wake up.

The projected power consumption for the HD decode of H.264 and MPEG2 is approaching 2W in active mode for the processor and 400mW for the memory. The active standby, passive standby and off processor power should be around the same as the SD box with the memory consuming about twice the amount of the SD solution.

Using the DaVinci solution the full power management of the tuner peripherals and the HDD is exercised by the DSP. The typical tuner/demod for digital terrestrial TV is 800mW and can be as little as 300mW DC. The calculation for a digital terrestrial STB receiving H.264 standard High Definition broadcasts and streaming to the TV High Definition Interlaced or progressive signals up to 1080 on analogue or digital HDMI interfaces is:

- On Active 5W from AC mains.
- Standby Passive (lowest allowing fast start) 250mW from AC mains.

In addition to the data provided by Texas Instruments for the Da Vinci BAT Silicon the following performance data was made available from a manufacturer with a competitive Terrestrial Digital TV Simple STB product in the European market (footnote TVOnics) This is for Standard Definition Digital TV services.

The Core chip set comprises

- Fujitsu H25 MPEG-2 SOC – 133Mhz ARC CPU
- Intel (Zarlink) 353 COFDM demodulator

The other key components are

- ALPS Tuner.
- AKM SCART switch/ Audio DAC.

Using a high efficiency external switching power supply (as provided with the product) the product performance figures with SCART TV connector and RF loop through active are:

On mode: 3.8W from AC mains 230V.

Standby passive mode: 1.4W from AC mains 230V.

With SCART connector and RF loop through disabled in standby (eco-mode) the standby passive power requirement is less than 1W.

6.4 Software design

Even a Simple STB isn't only a collection of electronic hardware components in a box. From the start of the STB development it is known that energy demand is determined not only by hardware selection but by intelligent software design as well. Using intelligent software design opens low power demand options even for very cheap Simple STBs using mass market "from the shelf" hardware components. Implementing a good software design provides a significant reduction of power demand in on-mode. Using properly designed software can detect and select the essential parts from the mpeg stream. This preselection reduces the working load of the processors what results in a lower power demand of these components. A good software design provides not only low power use of the hardware resources in on-mode, it offers additional features as low power standby-mode due to software triggered switch-off of components not used during the standby operation of the STB.

6.5 Power Supply Efficiency

6.5.1 Optimisation Of The Power Budget in STBs

Essential self-contained external and internal devices are an area where progress has been made in the optimisation of power requirement. Simple STBs include those for satellite broadcasting reception. An external device that is often ignored in the consideration of the STB energy efficiency is the power taken by the low noise block (LNB) used on satellite dishes.

Because of historical standards for voltage signalling LNBs are fed with a supply of 13V or 18V by the set top box. For a conventional single output LNB the DC power consumed can be between 1 and 2 watts. Even higher power is required for dual and quad LNBs. In traditional designs, most of this power is dissipated as heat in a linear regulator having an output of 5V or lower. Recently, some LNB manufacturers have produced more efficient designs using a switching buck converter to derive the low voltage needed. This can reduce the power load of the LNB by 60% typically.

6.5.2 Internal Power Supplies

There are several solutions available to the market to provide an energy efficient power supply for Simple STBs. The options mentioned in the following claim to reach the demands of the CoC guidelines as available for Simple STBs [67].

In 2003 *Power Integrations* offered a Design Accelerator Kit for standby and no-load operating conditions to meet energy efficiency guidelines for STBs. The DAK-32 featured a cost effective, energy efficient 20 W power supply reference design that easily met a 1-watt

[67]) European Code of Conduct for "Digital TV Service Systems (set-top boxes)"

standby input power consumption for STBs. The actual Design Accelerator Kit site of Power Integrations does not mention the DAK-32 any more. Instead there are DAK-33 and 34 for 30, respective 45 Watt designs.

The *Texas Instruments DaVinci Silicon* solution offers an AC to DC power supply conversion efficiency averages better than 86% falling to around 60% at standby level (sub 1W) DC to DC conversion efficiency on all voltage rails is better than 90% over a full load range (90% load to 0.1% load) [68].

Another solution to reduce the power consumption in Standby-mode is provided by the dSID-Chip of *DigitalSTROM* [69]. Besides other features the dSID-Chip is focussing on minimising standby power demand of electronic devices to as low as 0,3 Watts with the option of a fast restart to on-mode.

6.5.3 External Power Supplies

A result of the higher integration of the Simple STBs electronics is smaller casings. So the power supply gets the largest module of the STB. This is one reason for the use of EPS for compact and ultra compact Simple STBs. A second reason is the increasing heat problem as a result of the higher IC integration.

For details concerning the EPS market and respective technological development it is referred to the “Preparatory Studies for Eco-design Requirements of EuPs, Lot 7: Battery chargers & external power supplies”.

6.5.4 Hard Mains Switch vs. Low Standby

There is an ongoing discussion about the implementation of a hard mains switch in every Simple STB. Since former remote control based solutions used in TV sets (Dangschat patent) are not available any more due to the disappearance of the respective components because of RoHS problems, there is no remote control triggered solution for an electro-mechanical hard mains switch available.

As the majority of the consumers have the tendency not to use any mains switch to switch off their electronic devices completely from the electric grid the best available option to

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[68]) TI continues to develop highly integrated switch-mode power conversion devices suited to the multi-rail nature of modern processors. The efficiency at low loads is also a focus and dcdc converters usually drop from PWM mode to PFM mode (operate in a burst fashion) to bring the light load efficiency back up. The TPS65023 for example achieves over 90% efficiency under full load conditions and maintain that level down to 0.1% of the full load.

[69]) *DigitalSTROM,* a spin-off of the ETH Zurich, offers a new and unique technology for the measurement of electricity demand and energy management of all kind of home appliances. Implemented in new equipment or added to devices already available the highly integrated module provides a proven technology to manage and handle the energy demand from single households to whole buildings.

reduce power consumption of Simple STBs when they are not in On-mode would be a low standby demand. Since this is claimed by many manufacturers as to expensive and the hard mains switch is not used frequently by the consumer an auto electronic switch off could be a viable solution.

6.5.5 Low energy LNB solutions

DVB-S systems use a LNB (low-noise block) downconverter at the antenna that requires switchable 13 Vdc/18 Vdc power and a 22 kHz ac tone burst superimposed on the dc voltage for control signalling, both sent upstream by the RF front-end.

Traditional discrete solutions only support one-way communication from receiver-to-LNB peripheral. Preferable is a LNB that supports two-way communications according to the DiSEqC 2.x protocol.

As power efficiency gets more important, especially in multi-LNB and multituner-type PVR STBs, the manufacturers are looking for a power-efficient, switched-mode power supply solution using a boost converter topology. Manufactured in a high-voltage process, actual LNB supply IC are, unfortunately in many cases, not offered by the same supplier as the demodulator IC but does need to interact with this device. With it's series of RF front-end ICs *Silicon Laboratories (SiRX)* offers an integrated RF satellite front-end, consisting of tuner, demodulator, LNB signalling controller and LNB supply regulator.

6.6 Conclusion

The main focus in the development of Simple STBs was to cut the costs for manufacturing and to cut the costs for design of new Simple STBs. The rapid development of new higher integrated modules available from the vendor’s shelf offers the opportunity to refocus on new features of Simple STBs. Since some marketing departments would like to focus on new technological gimmicks as additional features there is a significant opportunity to implement low power consumption as a relevant product feature.
The main topics in this development are:

- Higher integration of chips
- More energy efficient software development
- Higher power supply efficiency
- Auto switch-off and low power standby.

6.7 New PCB Materials

Even if power demand in the manufacturing phase isn’t a main issue in the Simple STB’s lifecycle new PCB materials offer an opportunity to reduce the power demand in manu-facturing of Simple STBs.

Their main advantage is their huge potential concerning the improvement of the product recycling at the end of lifetime of the devices.

With a joint research project called “Thermoplastic Printed Circuit Boards as a Contribution to Closed-Loop Recycling (HTT-Board)” the an environmentally sound printed circuit board (PCB) based on highly temperature-resistant thermoplastics (HTT) is developed by Wurth Electronics, Oeko-Institut of Freiburg and others.

Since the recycling performance of thermosetting traditional PCB is poor, they contain ecologically precarious flame-retardants and the high continuous service temperatures bring them increasingly to the limits of endurance the new PCB provides better recyclability and the withdrawal of toxic flame-retardants as new and innovative technological features. The project could show that it is not only principally feasible to improve PCBs both ecologically and economically. The new HTT boards offer unfoamed flex-layer and multi-layer structures for complex and highly integrated applications.

The new boards can do completely without any flame-retardant system and are easy to recycle, thus offering two fundamental ecological benefits compared with conventional thermosetting PCB base material. Including all upstream processes, HTT boards cause only half the total environmental burden of conventional boards at roughly the same costs. The new printed circuit board is developed to be compatible with conventional PCB processing equipment, so that they can be used in a wide Range of industries.

Thermoplastic printed circuit boards are not destined to exist in niches. They are designed for the universal market of electric and electronic devices. HTT boards are printed circuit boards with ecological premium performance available for the mass market.

HTT boards are slightly more expensive than FR-4 boards but significantly cheaper than PTFE materials and they offer easier recycling via mechanical sorting and separation procedure using NIR (near field infra red) technology for material identification. The reduction of the amount of energy needed for the manufacturing process is an additional advantage of the HTT board technology.

7 Task 7: Improvement Potential

7.1 Introduction

With Task 7 “Improvement Potential” for the EuP Preparatory Studies on Simple STBs the results concerning the improvement potential to reduce the environmental impact are presented and their potential influence quantified. Several stakeholders provided the information used for this report. Since the market for electronics is developing very fast, all details in this report represent only the information status during the elaboration of the study. Under changing circumstances any forecast could be passed by the coming development.

Options presented in this task are examples for a possible improvement. The results shown are forecasts and not predictions. The options presented in this task are only for information purposes to show the availability of such an improvement. We do not claim they are the only existing solutions to achieve the targeted aims

Since the whole study focuses on technical solutions, potential public campaigns to influence consumer behaviour concerning Simple STB operation and switch-off are not part of this report.

7.2 Options

As seen from the previous tasks the biggest environmental impact of Simple STBs derives from the power consumption of these devices in their use phase. So the main target of Task 7 is on design and configuration options to reduce the power consumption in On-mode and Standby-mode.

A further potential improvement concerning Simple STBs is given with the replacement of PCBs by HTT boards. This technology is available and could be implemented at once. Due to the VHK EcoReport tool's fixed relations concerning the impacts of PCBs and the fast track status of this study a closer assessment of this option is out of reach within this task. Since the actual recycling schemes according to the WEEE directive do not foster the replacement of PCB technology by more environmentally friendly solutions this is another obstacle against the implementation of such a technology.

Since the HTT board technology as outlined in Task 6 could provide further improvement for other electronic devices it is recommended to arrange a closer review of the potential impacts of this new PCB technology within another EuP Preparatory Study.

Due to very conservative development in the PCB industry it takes up to 15 years to implement new PCB technologies. So there is enough time to change the EU regulation as the PCB recycling is affected.

Since the silicon industry is much faster with a typical innovation circle of about 2 years, the focus of Task 7 is on silicon solutions to optimise the power consumption of Simple STBs.

7.2.1 Power Consumption Improvement Options Simple STBs on-mode

The following list displays improvement options for the reduction of the power demand of simple STBs and Simple STBs / PVRs in On-mode.

Option	Specification of improvement	Improvement potential	Cost factor/ availability
System integration DaVinci silicon	Reduction of components Reduction of PCB size	Reduction of power demand	Cost neutral Available
Software	Software design	Reduction of power load	Cost neutral Available

Table 7.1: On-mode Power Consumption Improvement for Simple STBs

The higher system integration on silicon offers a decrease of manufacturing costs. The implementations of energy efficient options to reduce power consumption are not necessarily connected with additional costs. So the assumption is made, that the overall costs for the whole system are not increasing using more integrated chips. The higher standardisation of components used for STBs following the DVB standard will be another potential to cut costs due to increased production lots. A further cost cutting feature of higher integration is the miniaturisation of electronic board, i.e. the reduction in size of the PCB needed for assembling, since the number of components gets reduced.

Implementing optimised software allows reducing the power consumption in On-mode through improved video stream management. A calculation of the improvement is not possible since information about details is not available to the public.

Additional options to reduce the power consumption of STBs in On-mode as well as in Standby-mode are given by the selection of improved switch mode power supplies instead of simple linear converters.

As it is shown in the Preparatory Studies for Battery chargers & external power supplies [70] external power supplies in the output range of 6 – 10 watts for STBs are available providing an average efficiency of 79 % and no load power losses (average) of 0,15 watts.

If STB manufacturers change the product categories at their vendors catalogue and shift to power supplies as they are provided as chargers for mobile phones, they will get an opportunity to source comparable inexpensive mass market products, that offers much better energy efficiency as the “traditional” linear power supplies. [71]

There is one option available to make the STBs completely obsolete by integrating the functionality, i.e. the digital tuner into the TV sets. If the digital tuner will be integrated in to the TV-set this will result in either different TV-sets for each broadcasting system. Since there are different DVB-tuners (DVB-T,C,S) this will result in 3 product lines or the integration of 3 tuners in each TV-set, which could keep two of them in permanent standby-mode. Shifting to other transmission systems as IPTV would make all of them obsolete.

As an opposite option the separation of the receiver from the TV set should be discussed. A separation of the receiver and the strip down of the TV set to a kind of monitor as common in the broadcasting business provides a significantly higher flexibility for new broadcasting technologies.

As it is visible with the new HD ready TV sets only their display segment is HD ready. The receiver is not since the standards for example for DVB-T2 is not published yet. So customers who buy an HD ready TV set will need a new additional STB for HDTV. The TV set’s receiver will be obsolete after the introduction of HDTV a will consume power in vain.

[70]) Preparatory Studies for Eco-design Requirements of EuPs Lot 7: Battery chargers & external power supplies, page VII-37

[71]) An example for such a solution is given by TVonics and their MDR-200 Digital Set Top Box.

7.2.2 Power Consumption Improvement Options Simple STB Standby-mode

The following table displays improvement options for the reduction of power consumption in Standby-mode.

Option	Specification of improvement	Improvement potential	Cost factor/availability
System integration DaVinci silicon	Reduction of components Reduction of PCB size	Reduction of power demand	Cost neutral Available
Software	Software design	Reduction of power load	Cost neutral Available
Power supply dSID Chip	Additional features for in-house load management	Reduction of power demand in Standby-mode	Cost neutral, if integrated Available
Hard mains switch	Complete switch off power when not in On-mode		2-3 € extra cost

Table 7.2: Standby-mode Power Consumption Improvement for Simple STBs

The hard mains switch or primary side hard-off switch is a solution often claimed by standby-activists. The real problem with the hard mains switch is the user/consumer. When will he switch-off the STB completely. The results from polls like the dena/emnid poll in Germany are not promising concerning the consumer behaviour related to the mains switch (See Task 3 of this study). As seen from the poll results in Task 3 most consumers will not use the hard switch-off option of the STB. So a hard mains switch will add additional costs for the manufacturer. The former solution with the electromagnetic spring switch is no more available due to RoHS problems. There are doubts if such a solution would be available on the market again.

Implementing optimised software allows reducing the power consumption in Standby-mode through switch-off of components not used during the standby phase. A detailed calculation of the power reduction is difficult since information about details is not available to the public.

The reduction of Standby-mode consumption is just an additional feature of the dSID chip. Using the dSID chip within a digitalSTROM environment offers in-house load management and detailed measuring of power consumption of all electric/electronic devices per household. The reduction of standby power to less than 0,3 W is just a side effect.

The hard mains switch is not applicable for Simple STB / PVR since the PVR would lose it's time shift feature.

The options provided by improved external or internal power supplies are not presented here, as this topic is included in several other reports. So here it is only referred to these reports.

7.2.3 Definition of BAT options

In the following the presentation in Task 7 focuses on two BAT options. Both are examples of technology already available. The use of these examples in the report is only for reference to display what options are already available. The authors make now recommendations for the implementation of one or both or any other technology. There will be several other technologies available to achieve the same or even better results.

BAT option 1

This option focuses on the implementation of the DaVinci solution and higher integration of silicon for the Simple STB without any further features.

The power consumption of this version is in

On-mode: 5 Watts

Standby-mode: 0,25 Watts

For the Simple STB / PVR with an integrated hard disk we selected a medium power 3,5” hard disk. Using a 2,5” hard disk as they are used in notebooks, a further reduction in power consumption would be possible. Lowest available power consumption in this range is about 4 Watts. Since the respective technology is not available in the 320/500 GB size versions we kept the 3,5”-solution. For the hard disk power consumption in On-mode we got 8 Watts.

The power consumption of the PVR version is in

On-mode: 13 Watts

Standby-mode: 0,25 Watts (HD in sleep mode)

BAT option 2

The second BAT option is focused on the implementation of dSID chip to reduce the Standby consumption to less than 0,3 Watts. All other features are taken unmodified from the respective base case.

Simple STB without any further features.

The power consumption of this version is in

On-mode: 7 Watts

Standby-mode: 0,3 Watts

The power consumption of the PVR version is in

On-mode: 25,6 Watts

Standby-mode: 0,3 Watts (HD in sleep mode)

7.3 Impacts

Task 7 focuses on the quantitative assessment of the environmental improvement options. The MEEuP methodology requires making the following assessment by utilising the VHK EcoReport tool. The reduction of power consumption in On-mode and Standby-mode is the main sector of improvement. This can be assessed quite clearly by the EcoReport tool.

For the both BAT options the assumption is made, that they will not used as an add on concerning the silicon structure of the Simple STB but will be implemented in the next generation of products within a two years period. So there will be no extra silicon in the STBs. Since it is not known what volume/weight reduction could be realised with the new chip sets, we preferred to keep these numbers from the base case.

7.3.1 Impact Assessment of Improvement Options

Calculation of improvement potential related to BAT 1 (system integration)

Version 5 VHK for European Commission 28 Nov. 2005 — Document subject to a legal notice (see below))

ECO-DESIGN OF ENERGY-USING PRODUCTS

EuP EcoReport: **RESULTS**
Assessment of Environmental Impact

Table 7.3: Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television

Nr	**Life cycle Impact per product:**							Date	Author		
0	Simple STB Digital Terrestrial Television							04.10.07	ecostb.org		
	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			**426**			383	43	**426**	**0**
2	TecPlastics	g			**33**			30	3	**33**	**0**
3	Ferro	g			**293**			15	278	**293**	**0**
4	Non-ferro	g			**27**			1	26	**27**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**227**			115	112	**227**	**0**
7	Misc.	g			**211**			11	200	**211**	**0**
	Total weight	g			**1216**			554	662	**1216**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	255	53	**308**	**56**	**482**	40	41	**-1**	**844**
9	of which, electricity (in primary MJ)	MJ	149	15	**164**	**0**	**481**	0	13	**-13**	**631**
10	Water (process)	ltr	131	3	**134**	**0**	**33**	0	12	**-12**	**156**
11	Water (cooling)	ltr	90	15	**105**	**0**	**1279**	0	3	**-3**	**1380**
12	Waste, non-haz./ landfill	g	1310	110	**1420**	**53**	**570**	75	38	**36**	**2080**
13	Waste, hazardous/ incinerated	g	180	1	**181**	**1**	**13**	525	15	**510**	**705**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	14	3	**18**	**5**	**21**	3	3	**0**	**44**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	135	17	**152**	**13**	**125**	6	12	**-6**	**284**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**0**	**0**	0	0	**0**	**2**
18	Persistent Organic Pollutants (POP)	ng i-Teq	9	1	**10**	**0**	**3**	1	0	**0**	**14**
19	Heavy Metals	mg Ni eq.	26	2	**28**	**3**	**9**	11	2	**9**	**49**
	PAHs	mg Ni eq.	17	1	**18**	**3**	**1**	0	1	**-1**	**20**
20	Particulate Matter (PM, dust)	g	10	4	**15**	**2**	**3**	51	1	**51**	**70**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	58	0	**58**	**0**	**4**	3	7	**-4**	**58**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								
	***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**										

Table 7.3: Life Cycle Impact of Simple STB using BAT option 1

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ECO-DESIGN OF ENERGY-USING PRODUCTS

EuP EcoReport: **RESULTS**
Assessment of Environmental Impact

Table 7.4: Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television PVR

Nr	Life cycle Impact per product:							Date	Author		
0	Simple STB Digital Terrestrial Television PVR							04.10.07	ecostb.org		
	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			**274**			246	27	**274**	**0**
2	TecPlastics	g			**81**			73	8	**81**	**0**
3	Ferro	g			**1253**			63	1190	**1253**	**0**
4	Non-ferro	g			**777**			39	738	**777**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**277**			140	137	**277**	**0**
7	Misc.	g			**444**			22	422	**444**	**0**
	Total weight	g			**3105**			583	2523	**3105**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	303	72	**375**	**94**	**2073**	42	44	**-2**	**2540**
9	of which, electricity (in primary MJ)	MJ	158	23	**181**	**0**	**2071**	0	16	**-16**	**2236**
10	Water (process)	ltr	159	4	**163**	**0**	**140**	0	14	**-14**	**288**
11	Water (cooling)	ltr	83	19	**102**	**0**	**5520**	0	4	**-4**	**5618**
12	Waste, non-haz./ landfill	g	3191	190	**3382**	**72**	**2433**	190	47	**144**	**6031**
13	Waste, hazardous/ incinerated	g	275	1	**276**	**1**	**50**	456	18	**438**	**766**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	18	4	**22**	**8**	**91**	3	3	**0**	**120**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	161	23	**184**	**23**	**535**	6	14	**-8**	**733**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**1**	**1**	0	0	**0**	**3**
18	Persistent Organic Pollutants (POP)	ng i-Teq	34	3	**38**	**0**	**14**	1	0	**1**	**53**
19	Heavy Metals	mg Ni eq.	33	8	**41**	**4**	**36**	11	2	**9**	**90**
	PAHs	mg Ni eq.	18	1	**19**	**3**	**4**	0	2	**-2**	**25**
20	Particulate Matter (PM, dust)	g	15	6	**20**	**14**	**12**	54	1	**53**	**98**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	68	0	**68**	**0**	**14**	3	9	**-6**	**76**
22	Eutrophication	g PO4	2	0	**2**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								
	***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**										

Table 7.4: Life Cycle Impact of Simple STB / PVR (hard disk) using BAT option 1

Calculation of improvement potential related to BAT option 2

Version 5 VHK for European Commission 28 Nov. 2005 — Document subject to a legal notice (see below))

ECO-DESIGN OF ENERGY-USING PRODUCTS

EuP EcoReport: **RESULTS**
Assessment of Environmental Impact

Table 7.5: Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television

Nr	Life cycle Impact per product:							Date	Author		
0	Simple STB Digital Terrestrial Television							04.10.07	ecostb.org		
	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			**426**			383	43	**426**	**0**
2	TecPlastics	g			**33**			30	3	**33**	**0**
3	Ferro	g			**293**			15	278	**293**	**0**
4	Non-ferro	g			**27**			1	26	**27**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**227**			115	112	**227**	**0**
7	Misc.	g			**211**			11	200	**211**	**0**
	Total weight	g			**1216**			554	662	**1216**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	255	53	**308**	**56**	**655**	40	41	**-1**	**1017**
9	of which, electricity (in primary MJ)	MJ	149	15	**164**	**0**	**653**	0	13	**-13**	**804**
10	Water (process)	ltr	131	3	**134**	**0**	**45**	0	12	**-12**	**167**
11	Water (cooling)	ltr	90	15	105	0	1738	0	3	-3	1840
12	Waste, non-haz./ landfill	g	1310	110	**1420**	**53**	**770**	75	38	**36**	**2279**
13	Waste, hazardous/ incinerated	g	180	1	**181**	**1**	**17**	525	15	**510**	**709**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	14	3	**18**	**5**	**29**	3	3	**0**	**51**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	135	17	**152**	**13**	**169**	6	12	**-6**	**328**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**0**	**0**	0	0	**0**	**2**
18	Persistent Organic Pollutants (POP)	ng i-Teq	9	1	**10**	**0**	**4**	1	0	**0**	**15**
19	Heavy Metals	mg Ni eq.	26	2	**28**	**3**	**11**	11	2	**9**	**51**
	PAHs	mg Ni eq.	17	1	**18**	**3**	**1**	0	1	**-1**	**21**
20	Particulate Matter (PM, dust)	g	10	4	**15**	**2**	**4**	51	1	**51**	**71**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	58	0	**58**	**0**	**5**	3	7	**-4**	**59**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 7.5: Life Cycle Impact of Simple STB using BAT option 2

Version 5 VHK for European Commission 28 Nov. 2005	Document subject to a legal notice (see below))
ECO-DESIGN OF ENERGY-USING PRODUCTS	EuP EcoReport: **RESULTS** Assessment of Environmental Impact

Table 7.6: Life Cycle Impact (per unit) of Simple STB Digital Terrestrial Television PVR

Nr	Life cycle Impact per product:						Date	Author			
0	Simple STB Digital Terrestrial Television PVR						04.10.07	ecostb.org			
	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			**274**			246	27	**274**	**0**
2	TecPlastics	g			**81**			73	8	**81**	**0**
3	Ferro	g			**1253**			63	1190	**1253**	**0**
4	Non-ferro	g			**777**			39	738	**777**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**277**			140	137	**277**	**0**
7	Misc.	g			**444**			22	422	**444**	**0**
	Total weight	g			**3105**			583	2523	**3105**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	303	72	**375**	**94**	**4020**	42	44	**-2**	**4487**
9	of which, electricity (in primary MJ)	MJ	158	23	**181**	**0**	**4018**	0	16	**-16**	**4183**
10	Water (process)	ltr	159	4	**163**	**0**	**269**	0	14	**-14**	**418**
11	Water (cooling)	ltr	83	19	102	0	10712	0	4	-4	10810
12	Waste, non-haz./ landfill	g	3191	190	**3382**	**72**	**4691**	190	47	**144**	**8288**
13	Waste, hazardous/ incinerated	g	275	1	**276**	**1**	**95**	456	18	**438**	**811**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	18	4	**22**	**8**	**175**	3	3	**0**	**205**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	161	23	**184**	**23**	**1036**	6	14	**-8**	**1235**
17	Volatile Organic Compounds (VOC)	g	1	1	**2**	**1**	**2**	0	0	**0**	**4**
18	Persistent Organic Pollutants (POP)	ng i-Teq	34	3	**38**	**0**	**27**	1	0	**1**	**66**
19	Heavy Metals	mg Ni eq.	33	8	**41**	**4**	**69**	11	2	**9**	**124**
	PAHs	mg Ni eq.	18	1	**19**	**3**	**8**	0	2	**-2**	**29**
20	Particulate Matter (PM, dust)	g	15	6	**20**	**14**	**22**	54	1	**53**	**109**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	68	0	**68**	**0**	**27**	3	9	**-6**	**89**
22	Eutrophication	g PO4	2	0	**2**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 7.6: Life Cycle Impact of Simple STB STB / PVR (hard disk) using BAT option 2

Comparison of Base Cases and BAT Options

For the Base cases the Total Energy per unit (GER) during the use phase is

Total Energy in the use phase Simple STB 2877 MJ

Total Energy in the use phase Simple STB / PVR 5737 MJ

For the BAT option 1 the Total Energy per unit (GER) during the use phase is

Total Energy in the use phase Simple STB 482 MJ

Total Energy in the use phase Simple STB / PVR 2073 MJ

For the BAT 2 the Total Energy per unit (GER) during the use phase is

Total Energy in the use phase Simple STB 655 MJ

Total Energy in the use phase Simple STB / PVR 4020 MJ

7.4 Costs

Since the market for Simple STBs is very competitive any price increase due to implementation of one or both of the BAT options is not expected to lead to a price increase for the components needed. The effect of higher integration will reduce costs since the number of parts to be sourced and assembled will be reduced.

This assumption is made for an implementation within the next generation of silicon. New silicon generations will be available every 18 to 24 months.

A potential implementation of a new PCB technology is not calculated here since the very conservative PCB market needs up to 15 year to implement a new technology in the mass market.

7.5 Analysis LLCC [72]

Under the assumptions made above and with the results given an implementation of the BAT option 1 will result in the following LLCC (least lifecycle cost):

For a Simple STB without additional features the LLCC is: 56,00 Euro

For a Simple STB / PVR the LLCC is: 174,00 Euro

[72]) The LLCC calculations made in Task 7 are based on the BAT option. The increase in performance and reduction power consumption expected for several components including hard disks within the next 4 to 5 years will lead to a further reduction of the LCC as it is presented in Task 8.

7.6 Long-term Target (BNAT)

The BAT (Best Available Technology) for Simple STBs (digital to analogue converter) will obviously cover most demands concerning the reduction of environmental impacts as the main impact in the use phase could be reduced to an amount that will be quite difficult to measure in Standby–mode. For the devices described in this report a further reduction of power consumption in the use phase seems to be not helpful.

For the future there is one potential long-term target for many consumer electronics left to reduce the environmental impacts: The optimisation of the remote control.

With one branch of the HTT Board project mentioned above and in Task 6 a rigid board with a foamed sandwich structure, being suitable rather for basic applications like TV remote controls was developed.

This recently developed module of a foamed HTT board has a specifically low weight, is highly temperature-resistant and can also be post-formed thermally and mechanically. This feature opens up the opportunity to integrate switch and plug functions, which makes it possible to save components as well as cable and connecting devices. Moreover, foamed HTT boards show excellent high frequency properties.

In addition to using thin-wall injection moulding in order to achieve a weight reduction of compact parts, there is an increasing trend towards foamed polymers for technical applications. In comparison to compact polymers, such foams lead to a significant reduction of raw materials, decreased thermal conductivity, as well as good sound and mechanical damping.

A second problem of remote controls is the power supply of these devices. It is common to use two alkaline batteries of AA or AAA size per device. Micro fuel cell could be an option to reduce the environmental impact of the batteries. The availability of these products is not given yet.

7.6.1 Impact assessment of BNAT improvement options for Simple STBs

Using foamed boards a significant ecological optimisation of remote controls is possible. Foamed HTT boards offer the avoidance of toxic additives as flame-retardants and a material recycling at the end of its lifetime makes the product advantageous concerning ecology and economy.

Concerning the environmental impact of micro fuel cells no long time studies are available yet since a large scale serial production run of micro fuel cells has to start yet.

8 Task 8: Scenario, Policy, Impact, and Sensitivity Analysis

8.1 Introduction

The draft report of Task 8 “Scenario, Policy, Impact, and Sensitivity Analysis” for the EuP Preparatory Study on Simple STB presents some conclusions based on the findings of the research work of the Tasks 1- 7.

All recommendations in Task 8 are a result of the research of the authors of the study and are not to be perceived as the opinion of the European Commission.

8.2 Policy and Scenario Analysis

As seen from Tasks 1 – 7 the main environmental impact of Simple STB - with or without hard disk storage - is given by the amount of energy consumption during the use phase of the product. As shown in the preceding tasks there is a significant potential for the reduction of power consumption as well in On-mode as in Standby-mode. The potential is drawn from special and proprietary silicon, improved software and more efficient power supplies. While some manufacturers already implement significant power saving measures in their products others still ignore the topic. Tests conducted by Stiftung Warentest in Germany in 2007, and others around Europe show a wide range in the power requirement of Simple STB products. Consumer driven requirements for additional features, or design features driven by market competition, will potentially add to the power consumption to future Set Top Boxes.

8.2.1 Scenario Development

In the following scenarios for the years 2010, 2012, 2015 and 2020 are displayed. The scenarios 1, 3, 5 and 7 show the BAU situation for each of the years selected with no limits given for the energy consumption of simple STB and Simple STB / PVR in Standby-mode or On-mode. With the scenarios 2, 4, 6 and 8 the impact of the restrictions of the power consumption in Standby-mode and On-mode as scheduled is shown. Since the consumer behaviour concerning recording of TV broadcasts may vary from 4 hours viewing incl. recording up to 4 hours viewing plus 4 hours recording we added both versions (4 hour On-mode -P4- and 8 hours On-mode -P8-) to the scenarios. Table 8.1 shows the development of sales, replacement and stock for the coming decade from 2010 to 2020. As there are peaks of sales and stock between 2012 and the scheduled analogue switch-off in 2015 it is urgent to focus the development of energy efficient STB/PVR to synchronise with these peaks.

Year	Sales	Replacement	Stock
2010	28.5	9.0	89.8
2011	36.5	11.5	109.8
2012	35.0	13.2	125.1
2013	48.0	15.0	150.1
2014	56.0	17.5	177.6
2015	14.0	21.0	155.1
2016	12.0	15.0	132.1
2017	6.0	8.0	90.1
2018	2.0	6.0	36.1
2019	1.0	4.0	23.1
2020	0.0	2.0	11.1

Table 8.1: Digital Terrestrial STB EU 25 Totals [73]

[73] Source: Task 2 Table 3

Table 8.2 displays the power consumption limits for On-mode and Standby-mode and the deadlines as recommended in Task 8.1.2. Explanation and details are provided below at the respective chapter. The scenarios are in line with the deadlines for scenario 1 to 4 and will regard the year of the scheduled final year of analogue switch-offs, which will occur in Eastern Europe.

	Deadline	**Standby-mode**	**On-mode**
Simple STB (SD)	2010	1 W	5 W
Simple STB (SD)	2012	0,5 W	5 W
PVR allowance for hard disk (HD)	2012	-	+ 7 W
Allowance for 2nd tuner	2012	-	+ 1 W
Simple STB (HD)	2012	0,5 W	7 W *
PVR allowance for hard disk (HD)	2012	-	+ 7 W
Allowance for 2nd tuner	2012	-	+ 1 W
			*) incl. decoder and digital interface HDMI

Table 8.2: Power Consumption Limits for Simple STB and Deadlines

8.2.1.1 Scenarios for the Year 2010

Electricity tariff	14 Cent / kWh [74]	
On-mode	1460 hours / year (4 hours / day)	2920 hours / day (8 hours / day
Standby-mode	7300 hours / year (20 hours / day)	5840 hours / day (16 hours / day)

Year	Sales	Replacement	Stock
2010	28.5	9.0	89.8

Table 8.3: Basic Sale, Replacement and Stock [75]

Scenario 1 (BAU) Power Consumption

Assumptions for scenario 1:
6% of Stock, Sales & Replacement are PVR

Scenario 1S Simple STB	**Quantity**
Stock Simple STB	**84.12** (94 % of 89.8)
New devices Simple STB	**18.33** (94 % of 19.5)
Scenario 1P Simple STB / PVR	**Quantity**
Stock Simple STB / PVR	**5.39** (6 % of 89.8)
New devices Simple STB / PVR	**1.17** (6 % of 19.5)

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
1S (BAU)	Base case STB (SD)	7 W	6,1 W
1P (BAU)	Base case PVR (SD)	25,6 W	5,9 W

Power Consumption of Simple STB in Scenario 1

	New Devices	Stock	**Total**
Power consumption On-mode	187.33	859.70	**1047.03**
Power consumption Standby-mode	816.23	3745.86	**4562.09**
Total	1003.56	4605.56	**5609.12**

Total Power Consumption (in GWh) Scenario 1S Simple STB (BAU)(2010)

	New Devices	Stock	**Total**
Power consumption On-mode	43.72	201.42	**245.14**
Power consumption Standby-mode	50.39	232.14	**373.53**
Total	94.11	435.70	**618.67**

Total Power Consumption (in GWh) Scenario 1P4 PVR (4 h On-mode/d) (BAU)(2010)

	New Devices	Stock	**Total**
Power consumption On-mode	87.44	402.84	**490.28**
Power consumption Standby-mode	40.30	185.68	**225.98**
Total	127.74	588.52	**716.26**

Total Power Consumption (in GWh) Scenario 1P8 PVR (8 h On-mode/d) (BAU)(2010)

[74]) The electricity tariff of 14 Cent / kWh is an average of the tariffs in EU-25. An increase of the tariffs as expected will augment the impact of the measures on restricting power consumption.

[75]) Data according to Task 2 Table 2.2

Scenario 2 Power Consumption (measures of 2010 in operation)

Assumptions for scenario 2:
6% of Stock, Sales & Replacement are PVR

Scenario 2S Simple STB	**Quantity**
Stock Simple STB	**84.12** (94 % of 89.8)
New devices Simple STB	**18.33** (94 % of 19.5)
Scenario 2P Simple STB / PVR	**Quantity**
Stock Simple STB / PVR	**5.39** (6 % of 89.8)
New devices Simple STB / PVR	**1.17** (6 % of 19.5)

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
2S new devices	Low Power STB (SD)	5 W	1 W
2S stock	Base case STB (SD)	7 W	6,1 W
2P stock + new devices	Base case PVR (SD)	25,6 W	5,9 W

Power Consumption of Simple STB / PVR in Scenario 2

	New Devices	Stock	**Total**
Power consumption On-mode	133.80	859.70	**993.50**
Power consumption Standby-mode	133.80	3745.86	**3879.66**
Total	276.60	4605.56	**4873.16**

Total Power Consumption (in GWh) Scenario 2S Simple STB (2010)

	New Devices	Stock	**Total**
Power consumption On-mode	43.72	201.42	**245.14**
Power consumption Standby-mode	50.39	232.14	**373.53**
Total	94.11	435.70	**618.67**

Total Power Consumption (in GWh) Scenario 2P4 PVR (2010)

	New Devices	Stock	**Total**
Power consumption On-mode	87.44	402.84	**490.28**
Power consumption Standby-mode	40.30	185.68	**225.98**
Total	127.74	588.52	**716.26**

Total Power Consumption (in GWh) Scenario 2P8 PVR (8 h On-mode/d) (BAU)(2010)

The measures proposed for the year 2010 will only affect new products purchased by consumers in 2010. It will have no influence on the power consumption of the stock already available in European households.

	Simple STB	PVR (P4)	**Total**
Power consumption On-mode	1047.03	245.14	**1292.17**
Power consumption Standby-mode	4562.09	373.53	**4935.62**
Total	5609.12	618.67	**6227.79**

Total Power Consumption (in GWh) Scenario 1 (BAU)(2010) (Version P4)

	Simple STB	PVR (P4)	**Total**
Power consumption On-mode	993.50	245.14	**1238.64**
Power consumption Standby-mode	3879.66	373.53	**4253.19**
Total	4873.16	618.67	**5491.83**

Total Power Consumption (in GWh) Scenario 2 (2010) (Version P4)

	Simple STB	PVR (P8)	**Total**
Power consumption On-mode	1047.03	**490.28**	**1537.31**
Power consumption Standby-mode	4562.09	**225.98**	**4788.07**
Total	5609.12	**716.26**	**6325.26**

Total Power Consumption (in GWh) Scenario 1 (BAU)(2010) (Version P8)

	Simple STB	PVR (P8)	**Total**
Power consumption On-mode	993.50	**490.28**	**1483.78**
Power consumption Standby-mode	3879.66	**225.98**	**4105.64**
Total	4873.16	**716.26**	**5589.42**

Total Power Consumption (in GWh) Scenario 2 (2010) (Version P8)

Since the quantity of existing stock is about five times higher than the amount of new devices the energy saving potential that could be addressed for Simple STB in 2010 is about (5609.12 - 4873.16) 735.96 GWh.

Since the measures proposed for the year 2010 only focus on Simple STB without PVR feature, they will have no effect for the PVR sector (Total energy consumption savings potential of Simple STB + PVR: 6227.79 - 5491.83 = 735.96 GWh).

LCC for the devices of the scenarios 1 & 2

Given a product price of 50 € for a Simple STB the LCC varies as follows

LCC in Scenario 1S: Simple STB (base case / O: 7 W / S: 6,1 W)[76]: **83 €**

LCC in Scenario 2S: Simple STB (O: 5 W / S: 1 W): **59 €**

For a Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W)
with a product price of 150 € the LCC (Scenarios 1P4 & 2P4) is **199 €**

For a Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W)
with a product price of 150 € the LCC (Scenarios 1P8 & 2P8) is **216 €**

[76]) O: On-mode, S: Standby-mode

8.2.1.2 Scenarios for the Year 2012

Electricity tariff	14 Cent / kWh [77]	
On-mode	1460 hours / year (4 hours / day)	2920 hours / day (8 hours / day
Standby-mode	7300 hours / year (20 hours / day)	5840 hours / day (16 hours / day)

Year	Sales	Replacement	Stock
2010	28.5	9.0	89.8
2011	36.5	11.5	109.8
2012	35.0	13.2	125.1

Table 8.4: Basic Sale, Replacement and Stock[78]

Scenario 3 (BAU) Power Consumption

Assumptions for scenario 3:
25% of Sales & Replacement are PVR

Scenario 3a Simple STB	**Quantity**
Stock Simple STB	117.59 (94 % of 125.1)
New devices Simple STB	16.35 (75 % of 21.8)
Scenario 3b Simple STB / PVR	**Quantity**
Stock Simple STB / PVR	7.50 (6 % of 125.1)
New devices Simple STB / PVR	5.45 (25 % of 21.8)

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
3S (BAU)	Base case STB (SD)	7 W	6,1 W
3P (BAU)	Base case PVR (SD)	25,6 W	5,9 W

Power Consumption of Simple STB / PVR in Scenario 3

	New Devices	Stock	**Total**
Power consumption On-mode	167.09	1201.76	**1374.85**
Power consumption Standby-mode	728.96	5236.28	**5965.24**
Total	896.05	6438.04	**7340.09**

Total Power Consumption (in GWh) Scenario 3S Simple STB (Base Case SD)(BAU)(2012)

	New Devices	Stock	**Total**
Power consumption On-mode	203.66	280.27	**483.93**
Power consumption Standby-mode	234.73	323.02	**557.75**
Total	438.39	603.29	**1041.68**

Total Power Consumption (in GWh) Scenario 3P4 PVR (Base Case SD)(BAU) (2012)

	New Devices	Stock	**Total**
Power consumption On-mode	407.32	560.54	**967.86**
Power consumption Standby-mode	187.75	258.37	**446.12**
Total	595.07	818.91	**1413.98**

Total Power Consumption (in GWh) Scenario 3P8 PVR (Base Case SD)(BAU) (2012)

[77]) The electricity tariff of 14 Cent / kWh is an average of the tariffs in EU-25. An increase of the tariffs as expected will augment the impact of the measures on restricting power consumption.
[78]) Data according to Task 2 Table 2.2

Scenario 4 Power Consumption (measures of 2010 and 2012 in operation)

Assumptions for scenario 4:
25% of Sales & Replacement are PVR
35% of Stock is low power Simple STB

Scenario 4S Simple STB	**Quantity**	
Stock Simple STB (LP/Base Case)	44.5 (35 % of 125.1)	73.80 (59 % of 125.1)
New devices Simple STB	16.35 (75 % of 21.8)	
Scenario 4P Simple STB / PVR	**Quantity**	
Stock Simple STB / PVR	7.50 (6 % of 125.1)	
New devices Simple STB / PVR	5.45 (25 % of 21.8)	

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
4S Stock	Base case STB (SD)	7 W	6,1 W
4S Stock	Low Power STB (SD) (2010)	5 W	1 W
4S New devices	Low Power STB (SD) (2012)	5 W	0,5 W
4P Stock	Base case PVR (SD)	25,6 W	5,9 W
4P New devices	Low Power PVR (SD)	13 W	0,5 W

Power Consumption of Simple STB / PVR in Scenario 4

	New Devices	**Stock (LP/BC)**		**Total**
Power consumption On-mode	119.35	324.85	754.23	**1198.43**
Power consumption Standby-mode	59.67	324.85	3286.31	**3670.83**
Total	179.02	649.70	4040.54	**4869.26**

Total Power Consumption (in GWh) Scenario 4S Simple STB (2012)

	New Devices	Stock	**Total**
Power consumption On-mode	103.44	280.27	**383.71**
Power consumption Standby-mode	19.89	323.02	**342.91**
Total	123.33	603.29	**726.62**

Total Power Consumption (in GWh) Scenario 4P4 PVR (2012)

	New Devices	Stock	**Total**
Power consumption On-mode	206.88	560.54	**767.42**
Power consumption Standby-mode	15.91	258.37	**274.28**
Total	222.79	818.91	**1041.70**

Total Power Consumption (in GWh) Scenario 4P8 PVR (2012)

Comparison of the Scenarios 3 & 4 for the year 2012 (Version P4):

	Simple STB	PVR	**Total**
Power consumption On-mode	1368.85	483.93	**1852.78**
Power consumption Standby-mode	7423.16	557.75	**7980.91**
Total	8792.01	1041.68	**9833.69**

Total Power Consumption (in GWh) Scenario 3 (BAU)(2012) (Version P4)

	Simple STB	PVR	**Total**
Power consumption On-mode	1198.43	483.93	**1682.36**
Power consumption Standby-mode	3670.83	557.75	**4228.58**
Total	4869.26	1041.68	**5910.94**

Total Power Consumption (in GWh) Scenario 4 (Version P4)

Comparison of the Scenarios 3 & 4 for the year 2012 (Version P8):

	Simple STB	PVR	**Total**
Power consumption On-mode	1368.85	967.86	**2336.71**
Power consumption Standby-mode	7423.16	446.12	**7869.28**
Total	8792.01	1413.98	**10205.99**

Total Power Consumption (in GWh) Scenario 3 (BAU)(2012) (Version P8)

	Simple STB	PVR	**Total**
Power consumption On-mode	1198.43	767.42	**1965.85**
Power consumption Standby-mode	3670.83	274.28	**3945.11**
Total	4869.26	1041.70	**5910.96**

Total Power Consumption (in GWh) Scenario 4 (Version P8)

The Scenarios 3 & 4 for the year 2012 clearly show the power saving measures of 2010 and 2012. With the implementation of these measures the total power consumption could be cut by **48%** (Total power saving potential for all Simple STB in 2012: 9833.69 - 5132.31 = 4701.38).

LCC for the devices of the scenarios 3 & 4

Given a product price of 50 € for a Simple STB the LCC varies as follows
LCC in Scenario 3S: Simple STB (base case / O: 7 W / S: 6,1 W) [79]: **83 €**
LCC in Scenario 4S: Simple STB (O: 5 W / S: 0,5 W): **57 €**

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:
LCC in Scenario 3P4: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **199 €**
LCC in Scenario 4P4: Simple STB / PVR (O: 13 W / S: 0,5 W) : **164 €**

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:
LCC in Scenario 3P8: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **216 €**
LCC in Scenario 4P8: Simple STB / PVR (O: 13 W / S: 0,5 W) : **175 €**

[79] O: On-mode, S: Standby-mode

8.2.1.3 Scenarios for the Year 2015

Electricity tariff	14 Cent / kWh [80]	
On-mode	1460 hours / year (4 hours / day)	2920 hours / day (8 hours / day
Standby-mode	7300 hours / year (20 hours / day)	5840 hours / day (16 hours / day)

Year	Sales	Replacement	Stock
2010	28.5	9.0	89.8
2011	36.5	11.5	109.8
2012	35.0	13.2	125.1
2013	48.0	15.0	150.1
2014	56.0	17.5	177.6
2015	14.0	21.0	155.1

Table 8.5: Basic Sale, Replacement and Stock [81]

Scenario 5 (BAU) Power Consumption

Assumptions for scenario 5 BAU:	
Sales and Replacement: 20% Simple STB 80% Simple STB / PVR	Stock: 75% Simple STB 25% Simple STB / PVR

Scenario 5S Simple STB	**Quantity**
Stock Simple STB	116.32 (75 % of 155.1)
New devices Simple STB	2.80 (20 % of 14.0)
Scenario 5P Simple STB / PVR	**Quantity**
Stock Simple STB / PVR	38.77 (25 % of 155.1)
New devices Simple STB / PVR	11.20 (80 % of 14.0)

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
5S (BAU)	Base case STB (SD)	7 W	6,1 W
5P (BAU)	Base case PVR (SD)	25,6 W	5,9 W

Power Consumption of STB in Scenario 5

	New Devices	Stock	**Total**
Power consumption On-mode	28.61	1188.79	**1246.01**
Power consumption Standby-mode	124.68	5179.72	**5304.40**
Total	153.29	5298.51	**6550.41**

Total Power Consumption (in GWh) Scenario 5S Simple STB (BAU)(2015)

	New Devices	Stock	**Total**
Power consumption On-mode	418.54	1448.83	**1867.37**
Power consumption Standby-mode	482.38	1669.82	**2152.20**
Total	900.92	3118.65	**4019.57**

Total Power Consumption (in GWh) Scenario 5P4 Simple STB / PVR

	New Devices	Stock	**Total**
Power consumption On-mode	837.08	2897.66	3734.74
Power consumption Standby-mode	385.84	1335.63	1721.47
Total	1222.92	4233.29	5456.21

Total Power Consumption (in GWh) Scenario 5P8 Simple STB / PVR

[80]) The electricity tariff of 14 Cent / kWh is an average of the tariffs in EU-25. An increase of the tariffs as expected will augment the impact of the measures on restricting power consumption.

[81]) Data according to Task 2 Table 2.2

Scenario 6 Power Consumption (measures of 2010 and 2012 in operation)

Assumptions for scenario 6:	
Sales and Replacement 100 % High Definition devices 20% low power HD STB (HD) 80% low power HD PVR (HD)	Stock 75% low power Simple STB (SD) 25% low power Simple STB / PVR (SD)

After 2012 other devices as IPTV STB will replace a growing number of Simple STB. Thus the replacement numbers for 2015 are neglected for the calculation of new Simple STB, since IPTV STB use CA and are not in the scope of this study.

Scenario 6S Simple STB	**Quantity**
Stock Simple STB	116.32 (75 % of 155.1)
New devices Simple STB	2.80 (20 % of 14.0)

Scenario 6P Simple STB / PVR	**Quantity**
Stock Simple STB / PVR	38.77 (25 % of 155.1)
New devices Simple STB / PVR	11.20 (80 % of 14.0)

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby
6S Stock	Low Power STB (SD) (2012)	5 W	0,5 W
6P Stock	Low Power PVR (SD) (2012)	13 W	0,5 W
6S New devices	Low Power STB (HD)	7 W	0,5 W
6P New devices	Low Power PVR (HD)	15 W	0,5 W

Power Consumption of STB in Scenario 6

	New Devices (**HD**)	Stock (**SD**)	**Total**
Power consumption On-mode	28.61	849.13	**906.35**
Power consumption Standby-mode	10.22	424.56	**434.78**
Total	38.83	1273.69	**1341.13**

Total Power Consumption (in GWh) of Simple STB in Scenario 6S (2015)

	New Devices (**HD**)	Stock (**SD**)	**Total**
Power consumption On-mode	245.28	735.85	**981.13**
Power consumption Standby-mode	40.88	141.51	**182.39**
Total	531.44	877.36	**1163.52**

Total Power Consumption (in GWh) Scenario 6P4 PVR (2015)

	New Devices (**HD**)	Stock (**SD**)	**Total**
Power consumption On-mode	490.56	1471.70	**1962.26**
Power consumption Standby-mode	32.70	113.21	**145.91**
Total	523.26	1584.91	**2108.17**

Total Power Consumption (in GWh) Scenario 6P8 PVR (2015)

The power consumption of new devices in On-mode in the scenarios 5 and 6 is not comparable directly, since for the base case in Scenario 5 the STB and PVR are only SD products while in Scenario 6 the respective devices are HD products with a power consumption of max. 7 W (5 W + 2 W allowance for HD). Since the DVB-T2 (HD) standard is not published yet there are no such products available for the base case and no product data concerning power consumption are available. For the year 2015 a growing number of HD devices is expected. For this reason we decided to focus on these HD devices for the Scenario 6. For the year 2015 the comparison of the Scenarios 5 and 6 display the rising potential for energy saving with the implementation of the proposed measures to limit the energy consumption in two steps (2010 and 2012).

The total power consumption from Scenario 5 is 10569.98 GWh. This could be reduced by the measures mentioned above to 2504.65 GWh or **an energy consumption reduction potential** of about **75 %**. For the version P8 with a 4+4 hours On-mode operation of the PVR the over all reduction would be from 12006.62 GWh to 3449.30 GWh.

The realisation of potential mentioned is only possible, if the implementation of the measures will take place as proposed in the years 2010 and 2012. A later implementation will not impact on the peak period of STB sales until 2015.

	Simple STB	PVR	**Total**
Power consumption On-mode	1246.01	1867.37	**3113.38**
Power consumption Standby-mode	5304.40	2152.20	**7456.60**
Total	6550.41	4019.57	**10569.98**

Total Power Consumption (in GWh) Scenario 5 (BAU)(2015) (Version P4)

	Simple STB	PVR	**Total**
Power consumption On-mode	906.35	981.13	**1887.48**
Power consumption Standby-mode	434.78	182.39	**617.17**
Total	1341.13	1163.52	**2504.65**

Total Power Consumption (in GWh) Scenario 6 (2015)(Version P4)

While the implementation of horizontal Standby measures would be responsible for a total reduction of power consumption from **7456.60 GWh to 617.17 GWh**, the implementation of additional **vertical measures for STB would address an additional reduction of 1225.90 GWh** per year (3113.38 - 1887.48 = 1225.90 GWh).

As the assumption of only 4 hours in On-mode per day is very conservative and the tendency towards longer usage time per day is expected, the effect of a specific vertical measure that focus the On-mode, would be even higher. In The following the respective values are displayed for 8 hours On-mode per day. With the increase of the On-mode duration from 4 to 8 hours per day the impacts of horizontal Standby measures would be reduced.

	Simple STB	PVR	Total
Power consumption On-mode	1246.01	3734.74	**4980.75**
Power consumption Standby-mode	5304.40	1721.47	**7025.87**
Total	6550.41	5456.21	**12006.62**

Total Power Consumption (in GWh) Scenario 5 (BAU)(2015) (Version P8)

	Simple STB	PVR	Total
Power consumption On-mode	906.35	1962.26	**2868.61**
Power consumption Standby-mode	434.78	145.91	**580.69**
Total	1341.13	2108.17	**3449.30**

Total Power Consumption (in GWh) Scenario 6 (2015)(Version P8)

Given the assumption of an increase of the daily On-mode phase from 4 to 8 hours (4 hours recording plus 4 hours viewing) the impact of horizontal measures focussing on Standby-mode power consumption would be reduced and savings potential for Standby-measures would be 394.25 GWh lower. In reverse the impact of vertical measures targeting the On-mode power consumption would rise to a reduction potential of 2112.13 GWh (4980.75 - 2868.61 = 2112.13). This will provide a net potential for a reduction of the power consumption of 1717.88 GWh.

LCC for the devices of the scenarios 5 & 6

Given a product price of 50 € for a Simple STB the LCC varies as follows

LCC in Scenario 5S: Simple STB (base case / O: 7 W / S: 6,1 W): **83 €**

LCC in Scenario 6S: Simple STB (HD) (O: 7 W / S: 0,5 W): **58 €**

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:

LCC in Scenario 5P4: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **199 €**

LCC in Scenario 6P4: Simple STB / PVR (HD) (O: 15 W / S: 0,5 W) : **165 €**

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:

LCC in Scenario 5P8: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **216 €**

LCC in Scenario 6P8: Simple STB / PVR (HD) (O: 15 W / S: 0,5 W) : **178 €**

Under the assumption of a 24/7 On-mode operation of the PVR devices any horizontal measures concerning Standby-mode would have no impact at all.

If the On-mode would be extended from to a 24/7 operation of the Set Top Box with no Standby-mode phase left the following LCCs would be valid:

Given a product price of 50 € for a Simple STB the LCC varies as follows

LCC in Scenario 5S24: Simple STB (base case / O: 7 W / S: 6,1 W): **87 €**

LCC in Scenario 6S24: Simple STB (HD) (O: 7 W / S: 0,5 W): **77 €**

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:

LCC in Scenario 5P24: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **286 €**

LCC in Scenario 6P24: Simple STB / PVR (HD) (O: 15 W / S: 0,5 W) : **230 €**

8.2.1.4 Scenarios for the Year 2020

Electricity tariff	14 Cent / kWh [82]	
On-mode	1460 hours / year (4 hours / day)	*2920 hours / day (8 hours / day*
Standby-mode	7300 hours / year (20 hours / day)	*5840 hours / day (16 hours / day)*

Year	Sales	Replacement	Stock
2010	28.5	9.0	89.8
2011	36.5	11.5	109.8
2012	35.0	13.2	125.1
2013	48.0	15.0	150.1
2014	56.0	17.5	177.6
2015	14.0	21.0	155.1
2016	12.0	15.0	132.1
2017	6.0	8.0	90.1
2018	2.0	6.0	36.1
2019	1.0	4.0	23.1
2020	0.0	2.0	11.1

Table 8.6: Basic Sale, Replacement and Stock [83]

Scenario 7 (BAU) Power Consumption

Assumptions for Scenario 7:

Stock and Replacement: 100 % Base case PVR (SD)

Scenario 7 Simple STB / PVR (SD)(BAU)	**Quantity**
Stock Simple STB / PVR	11.1
New devices Simple STB / PVR	2.0

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby-mode
7 (BAU)	Base case PVR (SD)	25,6 W	5,9 W

Power Consumption (in GWh) of Simple STB /PVR in Scenario 7

	New Devices	Stock	**Total**
Power consumption On-mode	74.74	414.80	**489.54**
Power consumption Standby-mode	86.14	478.07	**564.21**
Total	160.88	892.87	**1053.73**

Total Power Consumption (in GWh) Scenario 7P4 Simple STB / PVR (SD)(BAU)(2020)

	New Devices	Stock	**Total**
Power consumption On-mode	149.48	829.60	**979.08**
Power consumption Standby-mode	68.90	382.39	**451.29**
Total	218.38	1211.99	**1430.37**

Total Power Consumption (in GWh) Scenario 7P8 Simple STB / PVR (SD)(BAU)(2020)

[82] The electricity tariff of 14 Cent / kWh is an average of the tariffs in EU-25. An increase of the tariffs as expected will augment the impact of the measures on restricting power consumption.
[83] Data according to Task 2 Table 2.2

The conversion from analogue to digital broadcasting started in Western Europe with standard definition (SD) broadcasting. For Eastern European countries the shift to digital will be linked with the transformation of SD broadcasting to high definition (HD). It is expected that most of Eastern European countries will pass by SD digital systems and switch immediately to HD. Most countries of Eastern Europe will start with a schedule for pay TV, but will introduce FTA services soon to foster the implementation of digital services. For these reasons we shifted the products regarded in the scenarios from SD to HD products during the timeline.

Scenario 8 Power Consumption (measures of 2010 and 2012 in operation)

Assumptions for Scenario 8:

Stock and Replacement: 100 % High Definition and PVR

Scenario 8 Simple STB / PVR (HD)	**Quantity**
Stock Simple STB / PVR	11.1
New devices Simple STB / PVR	2.0

Segmentation of Simple STB and Simple STB / PVR

Scenarios		Power cons. On-mode	Power cons. Standby-mode
8	Low Power PVR (HD)	15 W	0,5 W

Power Consumption (in GWh) of Simple STB / PVR in Scenario 8

	New Devices	Stock	**Total**
Power consumption On-mode	43.80	243.09	**286.89**
Power consumption Standby-mode	7.30	40.51	**47.81**
Total	51.10	283.60	**334.70**

Total Power Consumption (in GWh) Scenario 8P4 Simple STB / PVR (HD)(2020)

Power Consumption (in GWh) of Simple STB / PVR in Scenario 8

	New Devices	Stock	**Total**
Power consumption On-mode	87.60	486.18	**573.78**
Power consumption Standby-mode	5.84	32.41	**38.25**
Total	93.44	518.59	**612.03**

Total Power Consumption (in GWh) Scenario 8P8 Simple STB / PVR (HD)(2020)

As the Scenarios 7 & 8 show for the year 2020 the influence of the measures proposed is still significant with a total power consumption reduced from 1053.73 GWh to 334.70 GWh. **The saving potential is at least about 2/3.** As the Scenario 7 shows only SD PVR devices and the expectations for 2015 are HD PVR it is obvious that the power saving potential would be even higher than visible in the comparison of the two scenarios. HD PVR devices are expected to consume significantly more power than SD. Detailed data are not available since the DVB-T2 standard is not published yet.

	PVR (SD)
Power consumption On-mode	**489.54**
Power consumption Standby-mode	**564.21**
Total	**1053.73**

Total Power Consumption (in GWh) Scenario 7 (2020) (Version P4)

	PVR (HD)
Power consumption On-mode	**286.89**
Power consumption Standby-mode	**47.81**
Total	**334.70**

Total Power Consumption (in GWh) Scenario 8 (2020) (Version P4)

	PVR (SD)
Power consumption On-mode	**979.08**
Power consumption Standby-mode	**451.29**
Total	**1430.37**

Total Power Consumption (in GWh) Scenario 7 (2020) (Version P8)

	PVR (HD)
Power consumption On-mode	**573.78**
Power consumption Standby-mode	**38.25**
Total	**612.03**

Total Power Consumption (in GWh) Scenario 8 (2020) (Version P8)

LCC for the devices of the scenarios 7 & 8 (Version P4)

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:
LCC in Scenario 7: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **199 €**
LCC in Scenario 8: Simple STB / PVR (HD) (O: 15 W / S: 0,5 W) : **165 €**

LCC for the devices of the scenarios 7 & 8 (Version P8)

Given a product price of 150 € for a Simple STB / PVR the LCC varies as follows:
LCC in Scenario 7: Simple STB / PVR (base case / O: 26,5 W / S: 5,9 W): **216 €**
LCC in Scenario 8: Simple STB / PVR (HD) (O: 15 W / S: 0,5 W) : **178 €**

8.2.2. Policy Recommendations

For the consumer the power consumption of Set Top Boxes during the use phase is neither visible when buying new products, nor is this topic likely to be of primary interest in making purchasing decision. The increase caused to the consumers future electricity bills is unlikely to be associated with the product.

Many consumer electronics manufacturer focus on power consumption only if their products are provided for mobile use, where battery standby is a significant feature. For home and office use power consumption is still ignored by many manufacturers.

Special measures need to be implemented to convince manufacturers and distributors to reduce power consumption of their products in Standby-mode and in On-mod.

Since the STB market provides products for a transition period of changes between the analogue broadcasting area and the new digital services, the products supplied to the market started with the very simple Simple STB to offer a broader variety of added features in new devices as the market gets mature. As by definition in Task 1 the scope of this study is on simple STB with no conditional access (CA). This excludes any STB for the pay TV market sector. Products with integrated storage media as hard disk or solid disks are included, while exchangeable media as recordable/rewritable CD/DVD and USB sticks are not.

The measures proposed are the limitation of On-mode and Standby-mode consumption of Simple STB and PVR and additional allowances for additional features.

	Deadline	Standby-mode	On-mode
Simple STB (SD)	2010	1 W	5 W
Simple STB (SD)	2012	0,5 W	5 W
PVR allowance for hard disk (HD)	2012	-	+ 7 W
Allowance for 2nd tuner	2012	-	+ 1 W
Simple STB (HD)	2012	0,5 W	7 W *
PVR allowance for hard disk (HD)	2012	-	+ 7 W
Allowance for 2nd tuner	2012	-	+ 1 W
*) incl. decoder and digital interface HDMI			

Table 8.7: Power Consumption Limits for Simple STB and Deadlines

The first deadline for an On-mode power limitation to 5 W and a Standby-mode power limit of 1 W is set for the year 2010. This is in line with the next step of expected higher integration of the STB electronics. If such design changes could start immediately, volume production would be possible within 18 months. Allowing 9 months for procurement, the year 2010 fits exactly. The availability of such more energy efficient devices in the retail market in 2010 would be possible. Using the time available efficiently, the peak sales period before Christmas 2010 could be reached without trouble.

A second step of power demand reduction should be implemented in 2012. Including a power demand restriction to new PVR products to a maximum of 5 W for the basic STB plus an allowance of 7 W for the hard disk and 1 W for the second tuner that is needed for independent recording while watching a different programme. In 2012 the Standby-mode power demand for all devices will be cut by 50 % to only 0,5 Watts.

There are two reasons for the two steps. One is the option to keep the reduction deadline in line with the horizontal measures on schedule for Standby products. The second is the expected availability of power efficient hard disk drives, to the consumer electronics market, in bulk quantities and at reduced price by 2012.

Designers of Simple STBs for Standard Definition already have access to low power components and software design that will allow the required 2010 targets to be met with conventional silicon.

8.3 Impact Analysis Industry and Consumers

8.3.1 Impacts on Manufacturers

As the first deadline for a reduction of power consumption in On-mode and Standby-mode is not until 2010, this is within the design and manufacturing cycle of a Simple STB for all manufacturers.

With an implementation process in place to ensure the application of this deadline, permanent market pressures to be more cost effective will be met by further integration of the STB electronics rather than by inefficient low cost design. In line with this coming step to higher integration a re-design of almost all products is on schedule and there should be no real obstacle to change the electronic design to a more energy efficient one. Taking into account a design cycle of 18 months and 9 months for procurement, the deadline in the year 2010 is not out reach. Since the implementation of higher energy efficiency in line with the new product design will not lead to higher costs and higher prices, there is no reason for the manufacturer to postpone the implementation of the lower limits. For the transition period before the specific measures the manufacturer and the distributors could use the implementation of the lower power consumption for marketing purposes. This opportunity will only be available for a short time. After the implementation of the scheduled measures the low power feature will lose its marketing potential.

With the second step in 2012 the power limitation is focussing on the PVR and their power consuming hard disks. For the year 2012 the general availability of low cost power efficient hard disks for the consumer electronics market in bulk quantities is expected. This will stabilise or even reduce component-sourcing costs for PVR manufacturers.

With these two deadlines implemented, without option, the supply of energy efficient components from vendors through established supply chains should be possible without creating any shortages that could hamper the manufacture of energy efficient products. Existing, competitively marketed , Standard Definition STB products already meet the 2010 power requirement targets clearly demonstrating the viability of these targets.

8.3.2 Impacts on Consumers

The general re-design of the STB and PVR to meet the implementation targets suggested should drive the volume production and application of efficient components and software solutions and provide stable product prices for consumers. With a level playing field on energy efficiency, the Consumer will benefit from product competition through design and manufacturing quality, electronic and ergonomic performance and features.

The reduced energy consumption during all sectors of the use phase will benefit the consumer through the lowering or stabilising of electricity bills.

The general assumption of a daily On-mode of only 4 hours could be quite conservative and may expand to a much longer period per day. The benefit of significant reductions in On-mode power may well be as important as the horizontal measures proposed for standby power.

The risk that customers will miss a known product on the shelves because it is withdrawn for non-compliance with power consumption targets is not significant. Brand building, through Simple STB products alone, is not relevant to the majority of manufacturers.

8.4 Sensitivity Analysis of Main Parameters

The electricity tariffs used in this study are only an average of actual costs in EU-25. Since the variation of tariffs in EU-25 is still significant, the impact of the measures will be lower in countries with lower electricity tariffs. The move to a more general level for energy costs in Europe might be slow, but the existing variation will be reduced. This will flatten the discrepancies between different EU countries.

A predicted energy price increase in most countries will increase the impact of the measures proposed, since electricity costs during the use phase of the products are seen as the most significant in the Life Cycle Costs of Simple STBs.

An examination of the scenarios for the year 2015, when the Simple STB will reach peak distribution in European households, shows that Standby power requirement provides the largest energy saving potential.

The implementation of horizontal Standby measures would be responsible for a total reduction of power consumption of STB in Standby from 7456.60 GWh to 617.17 GWh. Since this potential could only be targeted, when and if the devices are in Standby, the assumption of 20 hours in Standby-mode per day could be compromised by user behaviour. In this context, an auto–standby feature may be an essential criterion for the Simple STB. As the implementation of additional vertical measures for STB while in On-mode drive up energy saving to 1225.90 GWh per year, a longer use phase per day will raise the impact of the proposed measures. With the expected significantly longer daily use phase - shown with the P8 version of the scenarios - and the shift to HD broadcasting in mind, a savings potential of about 2000 to 3000 GWh could be expected.