AEA Energy & Environment
From the AEA group

EuP Group Analysis (I), Lot 3: Sound and Imaging Equipment

Annex: Digital Picture Frames (DPF) - Task 1-3 Report

Report to European Commission DGENTR

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Table of contents

Executive Summary

Digital Picture Frames (DPFs) or Digital Photo Frames are a relatively new product group that entered the market scene in 2005 for the first time. A DPF is an electronic device that consists of a LCD display to present pictures and with newer products even videos including sound provided by one or two small loudspeakers. Most DPFs are mains powered with some containing additional rechargeable batteries for mobile use. Most DPFs are equipped with an external power supply, only one device is known with an internal power supply. Internal electronics include a central processing unit similar to a small computer and some amount of memory to keep the picture data and slots for data cards such as SD or compact flash cards and USB connectors. DPFs came to market as an option for manufacturers to make use of their overstock of small and medium sized LCD displays that they could not sell to PC-monitor and notebook manufacturers anymore, the products were introduced into the new market with growing success. Starting as a fancy product the devices entered the sales programme of many companies involved in the marketing of consumer electronics. Starting as a niche product the DPFs are covering more niches from month to month. With similar electronic ingredients the main difference between DPFs is the style of the frame and the size of the LCD display. Mains powered DPFs start at a size of 17 cm switching to 20 and 25 cm at present. The biggest DPFs known to date are 82 cm in diameter. A main advantage of DPFs for manufacturers and marketers emerged from the unique advantage of the product as a kind of chameleon. Using the same electronic ingredients it is easy to create a new product by just changing the frame. By changing the frame the DPF can adopt any fashion style quite easily and at very low costs compared with other products.

The easy adoption of new styles at low costs gives the manufacturers the option to cover almost every demand of the customers concerning external design. With such an easy tool at hand a growing number of marketers are entering the market with an increasing variety of products similar to the fashion industry. With a price level around the 100 Euro mark, DPFs are an excellent present for friends and relatives with the DPFs memory filled up with personal pictures. Used as a present most DPFs are purchased in the period leading up to Christmas. With all these product related advantages for manufacturers and customers the sales numbers of DPFs are expected to grow for the next decennium. For the year 2020 a total stock of about 155 millions of DPFs within the EU-27 is estimated.

While the issues of stand-by and external power supplies are covered by the respective Regulations[1] the on-mode is not. While some DPFs are supplied with an always-on mode as the only operational mode, others could be switched-off or provide an integrated timer so they could be switched-off automatically. With an average on-mode consumption of about 10 watts per device it is the number of DPFs and the time the devices are switched-on that are relevant.

Due to the relatively short availability on the market detailed user behaviour information is not known as yet. As the German consumer safety organisation Stiftung Warentest - who tested DPFs in 2008 - made the assumption of a 10 hours use time in on-mode additional to a 24/7 operation for devices without an off-switch, a similar user behaviour was assumed for this study.

Energy consumption in on mode was recognised as the main significant environmental impact. A first screening illustrated the impact of an auto-power down feature as the main improvement potential to reduce the power consumption during the product's use phase. The implementation of a timer to switch-off is not available in most devices yet. Since there is a clock module integrated in the electronics it is possible to use this clock to run a software timer to power down the device after a certain time. The implementation of such a timer is possible at extremely low cost since it is possible without any specific hardware as a software solution only that needs to be implemented as the factory set-up.

For customers who want to watch the pictures for more than two hours it should be possible to override the factory set-up. It is expected most users will not change the two hours limit set up by the factory. There should be a message on the screen about five minutes before power down to inform the

[1] COMMISSION REGULATION (EC) No 1275/2008 of 17 December 2008 with regard to ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment;
COMMISSION REGULATION (EC) No 278/2009 of 6 April 2009 with regard to ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies.

user about the power down feature. This would prevent the user from sending back the device to the dealer complaining about product failure.

As the standby regulation 1275/2008 provides the requirement of a "power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into: — standby mode, or — off mode, or — another condition" and "in order to prevent unnecessary losses of energy, products should ideally enter into a '0-Watt' consumption state when providing no function" no detailed measures are provided. With the implementation of an auto-power down two hours after the start of the device as a factory set-up, this detailed measure proposed by the study would be easy to implement and easy to control.

As with the Energy Star programme that integrated the DPFs into their programme for computer monitors now called 'programme for displays V5'[2] it is recommended to integrate the DPFs into a measure for computers and PC monitors with the addition of an auto-power down after two hours as a factory set-up.

In fact there are other environmental impacts. These will be broadly similar to those for computer monitors and TVs. The RoHS and WEEE Directives tackle hazardous materials and recycling respectively. Mercury in LCD backlights is a well known issue for which RoHS sets limit values. Recognising these limits are likely to become more stringent in time, manufacturers are responding by replacing CFL lamps with LEDs. It is noteworthy that two major manufacturers have publicly declared their intention to remove CFLs from laptops displays by the end of 2010 replacing them with LEDs (Ecolabel Second Discussion Paper, May 2009). For DPFs most backlights are replaced by LED already. Only a few low cost entry level products are still available with CFL lamps.

Recommendation for EU policy makers

DPFs should be added to the regulation for computers and computer monitors since the technology of computer monitors and DPFs is basically the same.

As an addendum for DPFs the on-mode is not limited to any input data transmission but limited by a factory pre-set on-time with an option for the user to override the factory setting. There should be a message on the screen about 5 minutes before the power down that gives the user the information that there is a power down implemented that could be changed by the customer using the products menu visible as an on screen display. This would prevent customers from returning the device to the dealer complaining product failure.

It is predicted that DPFs will continue to be purchased on an ad-hoc or impulse basis for the foreseeable future. Adding DPFs to the European ecolabel for computers is therefore unlikely to have a significant impact on the buying decision.

If these recommendations are adopted, it is estimated, on the basis of data available to this study, that 4 TWh of energy could be saved in 2020 relative to the current base case DPF energy impact analysis. Other environmental impacts of DPFs are not considered significant in the context of the total environmental impact scope of the computer and computer monitor product types.

Due to the market structure with many niche products and with most of the relevant marketing companies and respective brand owners located in Europe and the development and manufacturing of the DPFs in East Asia there is a demand for a mandatory measure. If there is a mandatory measure this will be part of the product specification for the coming generation of DPFs.

For a typical usage pattern (2 hours per day), typical energy consumption (10W for a small screen) and typical life time (6 years), energy consumption in use will account for an estimated two thirds or more of energy use across the life cycle.

New designs of DPFs will be equipped with WiFi/LAN modules to operate in an in-house network, therefore these DPFs should be covered by the EuP study LOT 26: Networked Products.

[2] US Energy Star Program Requirements for Displays (Version 5.0), www.energystar.gov

1 Task 1 - Definition

1.1 Introduction

The European Union (EU) has established competitiveness and sustainable development as two priority policies. Considering these, DG Enterprise and Industry promotes the integration of sustainable development with other policies fostering the EU's competitiveness including those connected with entrepreneurship and innovation and the Lisbon Agenda.

Within this a key area is sustainable industrial policy that aims to foster development of environmental and energy efficient products within the internal market. The Ecodesign Directive (2005/32/EC) is central to the approach. It sets out a coherent, consultative mechanism by which requirements can be set for energy using products whilst ensuring the free movement of such products within the market.

Energy using products have been recognised as important because they are responsible for a significant fraction of the energy and other resources consumed by the EU. There is also considerable potential for reducing the associated environmental impacts by adopting ecodesign measures at the product design stage because at this point up to 80% of a product's life cycle impacts are determined whether these be emissions to air and water, water use or waste generation. Hence if eco-design is to reflect holistic thinking then it is appropriate to take account of the whole life cycle at the design stage.

The adoption of the Ecodesign Directive paves the way for the development of implementing measures to regulate the environmental characteristics of EuPs whilst fully respecting the economic factors associated with making change. The Directive itself requires the Commission to ensure that related activities involve:

- The balanced participation of all member States,
- The participation of all relevant stakeholders for a particular product group including producers, traders, retailers, importers, NGOs and consumer groups.

The Commission established in 2004/05 a well-defined approach to the development of implementing measures – the Methodology for the Eco-design of Energy Using Products (MEEuP). This sets out a common method to gather information to help define implementing measures. The method involves the use of a simplified life cycle tool (EcoReport).

The first step of the MEEuP method is to undertake a preparatory study. These are undertaken for a particular EuP product group with the express purpose of providing the necessary information to prepare the Commission for subsequent activities including consultation with the Forum, an impact assessment and defining draft implementing measures.

The work required by DG Enterprise and Industry will, using the established MEEuP methodology, gather information regarding market characteristics, trends, environmental impacts, consumer behaviour, standards and test methods, stakeholder opinion and scope for improvement and the associated costs. In doing so it will provide information that helps policy makers develop minimum requirements for energy-using products, complemented with, where appropriate, voluntary "lead" standards, benchmarks, labelling and incentives to drive performance upwards. A public access website is kept up to date with the most significant developments within the study.

In particular this annex of the study will:

- Develop a product definition to be used throughout the work;
- Identify relevant existing legislation and standards;
- Develop an economic and market analysis for the product, including market structure and trends;
- Name the significant environmental impacts of the product
- Name costs of design and production to reduce environmental impacts and other necessary economic conditions for cost-effective ecodesign requirements;

- Identify the impact of specific measures on the competitive situation of market players and employment conditions;
- Identify the needs and generic requirements for standards to be developed;
- Identify via consultation self-regulation initiatives by industry.

1.2 Product Category and Performance Assessment

The generic products in this annex to the preparatory study are:

> Digital Picture Frames (DPFs) for stills and video display including versions with own SIM-card for picture transfer

It is only some months ago that Digital Photo Frames were struggling to find their place on consumers' wish list. Introduced in 2005, the DPF initially was only purchased by early adopters and very few others. Most consumers did not see much use in a product that only displayed the same pictures over and over again and had a much inferior image quality compared to a picture print.

In 2007 falling prices and additional features made DPFs more attractive to consumers with many branded and non-branded devices entering the market. Finally during the pre-Christmas season of 2008, the market for picture frames started up. Before the actual economic crisis **iSuppli Corporation** estimated the worldwide shipments to grow by nearly a factor of four to reach 78.3 million by 2011. In 2009 the company reduced their estimation for 2011 to 31.3 million devices [3]

1.2.1 Existing Product Definitions

To define these products, trade categorisations, tax categories (for example for picture frames), voluntary and mandatory initiatives, and relevant test standards were studied. For the definition of some of the products covered by this study the following sources are considered the most appropriate: the US Environmental Protection Agency (EPA) for Energy Star and definitions given in International measurement and testing Standards for a product genre. Products not defined by these sources include those categorised under the groupings, B) and D) that follow. The definition discussion for these products concludes with a suggested generic definition.

What is a *Digital Picture Frame* and what specifications are used?

Digital picture frames (DPFs) are a fast growing segment of electronic consumer products for the display of images emerging to video including sound. Most DPFs come with a configuration for a 24/7 operation. Some are without an on-off function and some are always on. Due to some tests lifetime energy consumption cost could be higher than purchasing costs of the device. They are covering several niche markets, where they add new functionality to existing products or try to replace other products. Actually some enter the DVB-T segment for mobile sets. Due to the products structure new features could be added easily to cover new niche markets and even partly replace computer monitors.

A digital picture frame (DPF) is used to store and display digital images on a liquid crystal display (LCD) screen. When the size of desktop and notebook screens became bigger manufacturing lines for smaller displays were at the risk of going out of business. The “invention” of DPFs was a solution to provide a new channel for the manufacturers to sell their products. DPFs started with low resolution and low picture quality.

A DPF typically includes an internal memory for storing images to be displayed by the device. At least one memory card or a USB stick can be connected to most DPFs to add memory to the device and for picture transfer. Some DPFs accept the same type of memory card as digital camera, which makes it easier to swap the card with the pictures between the two. Some DPFs offer USB / OTG (On The Go) for a direct connection of mobile hard disks without PC.

One or more user interface buttons may also be provided in order to allow a user to select which image stored in memory is to be displayed. Some DPFs can be controlled by a remote control similar to a TV-set.

[3] iSuppli Consumer Platforms Q1 2009 Market Tracker (www.isuppli.com)

As with monitors the screen size of a digital picture frame is still measured in inches diagonally from corner to corner. This should be the size of the visible area of the display and should not include the surrounding frame. Typical Screen Sizes are from 17.8 to 38.1 cm (7" to 15”), but screen sizes available are up to 81 cm (32”). Similar to TV screens DPFs are available with aspect ratios of 4:3 and 16:9. The aspect ratio is the displayed width divided by its height. Pictures (and videos) can be cropped to fit most digital photo frames. The displays used in DPFs are available with a typical resolution of 640 x 480, 720 x 480, 800 x 480 or 800 x 600. The resolution is the number of pixels that a DPF can display. The higher the resolution the crisper is the image. Since higher resolutions look better on larger screens there is a tendency to increase the size of the DPF. For smaller sizes new product features are created. Some of these features need hardware changes or add-ons. There are for example connectivity features as Wi-Fi, LAN, GSM or DECT.

With a Wi-Fi equipped DPF it is possible to send pictures from a PC to the frame wirelessly. This makes it easy to display changing collections of pictures from the home PC. An access to a Wi-Fi access point is needed to make use of this feature. Similar options are available with DPFs that are equipped with a RJ-45 socket for LAN connection by cable. DPFs marketed by mobile phone companies come with a GSM module and SIM card. This feature offers the option to send MMS from a mobile phone straight to the DPF. DECT capable DPFs offer the option to register them to the base station of a cordless DECT phone. Since they are able to use the Clip function of the DECT system they will display a picture of the caller, if his or her picture is in the library of the DPF. The library is stored in the DPFs internal memory.

Since DPFs were originally only designed to display images newer products offer video capability. With the video option the sound entered the DPF. There are versions with mono and stereo speakers. Sound options are now available as background music for slide shows.

For the power supply DPFs usually are connected to external power supplies (EPS). With the addition of rechargeable batteries to the DPFs a new type of product emerged: the mobile DPF. Mobile DPFs that are operational when connected to grid for recharging are covered by the study. Mobile devices that are only operating on batteries are not included since they are optimised for low power consumption already to provide an extended operation time. When the battery is empty they switch off automatically. Operation time of most battery powered DPFs (17 cm) is about 2 hours. For these products a 24/7 operation is not possible since they need recharging breaks. DPFs with an option for mobile operation are equipped with a rechargeable battery. The EPS is not part of the study since there is an EU regulation on EPS already[4] and batteries are not in the focus at present.

Since DPFs are a new product group there is no suitable Prodcom definition. The tariff code for DPFs for customs purposes is: 8521 9000 90. This is also the code for digital cameras and video devices.

The Energy Star programme includes the DPFs into electronic displays[5]. For Energy Star a electronic display is a commercially-available product with a display screen and associated electronics, often encased in a single housing, that as its primary function displays visual information from (i) a computer, workstation or server via one or more inputs, such as VGA, DVI, HDMI, or IEEE 1394, or (ii) a USB flash drive, a memory card, or wireless Internet connection. Common display technologies include liquid crystal display (LCD).

Against this background, the stakeholder meeting on sound and imaging equipment suggested the following tentative definition[6]:

A digital picture frame is a product that:
- Stores digital images/video internal or external memory
- Displays digital images/video internal or external memory
- Uses a display screen
- Is primarily mains operated

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 an ecodesign measure? 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.

[4] See footnote 1 for reference.
[5] See footnote 2 for reference.
[6] Minutes of the first stakeholder meeting of the preparatory study on sound and imaging equipment on 12 May 2009, www.ecomultimedia.org

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

1) the product does not meet the accepted product definition on which the specific eco-design criteria is based and therefore need not comply with related regulatory parameters
2) 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 (loopholes, as they are known, for the circumvention of the standby regulation by adding a RJ 45 socket to the product to create a "networked product").

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

What are the trends expected for the product groups in this study that may qualify the accepted or suggested product definitions? Trends for this product group in terms of technology development and market uptake are under investigation and will be discussed at the stakeholder workshop.

Digital Picture Frames

The DPF market is split into several niche markets. This will be the trend for the next few years. Since the basic CPU of the DPF offers an easy addition of features by software changes or additions there are a lot of future niches available. Changing the casing changes the picture frame to a photo album. Adding new hardware modules on the PCB is easy with 'piggy back' PCBs or re-designed PCBs.

Creating combo versions with solutions that are available already offer another big potential for new products based on the existing version. The availability of bigger panels due to a potentially shrinking display market for big desktop and notebook screens will see larger screen DPFs such as a new 32" DPF from one manufacturer.

According to GfK 450,000 digital picture frames were sold in Germany in the period leading up to Christmas 2008. This was an increase of 200% in relation to the pre-Christmas sales of 2007. For the whole year the sales tripled to 1 million pieces compared with the year before.

For the future GfK estimates a similar growth. GfK indicates that there are versions of picture frames that offer the display of the weather forecast, radio services and alarm clock functions as well as video display options. Other additional functions are: face recognition, optimising of the colour of the skin, red eye reduction and other integrated picture optimizing functions. (Source: GfK[7])

Before the actual economic crisis **iSuppli** estimated the worldwide shipments to grow by nearly a factor of four to reach 78.3 million devices by 2011.

Typical DPFs are shown in the pictures below. Since DPFs are covering many niches in the market new designs are arriving almost every week to meet demands of newly focussed customers.

[7] "Schick, schlau und gefragt Digitale Bilderrahmen - Über eine Million Stück in 2008" (www.photoindustrie-verband.de/)

    	
Digital Picture Frame	**Digital Presenter** **Digital Photo Album**
DPF with tuners DPF with motion picture playback DPF with wireless / LAN connectivity DPF with GSM (MMS) connectivity DPF with DECT connectivity	DPF with modified casing

1.2.2 Scope of the Study

After several discussions with stakeholders the scope for this annex was put on influencing consumer behaviour during the use phase of the devices. A first screening provided significant potential to reduce the energy consumption within the use phase of the products without significant extra cost for such a solution and expected acceptance by the users.

A significant environmental impact area under investigation within this preparatory study will be the product energy efficiency. In particular the preparatory study will investigate power consumption during the in-use phase of the life cycle.

Whilst the energy used during product operation is often described as having the largest share of total lifecycle impacts, "notable" impacts are present in other life cycle stages from manufacture to final disposal. Product design can play a major part in reducing some of these other lifecycle impacts. As such, as part of this Lot 3: Sound and Imaging Equipment project the project team will investigate the major environmental impacts occurring in each stage of the covered products' lifecycle stages. These investigations will centre on the following categories:

1. Environmentally sensitive chemicals and materials
2. Materials design
3. Design for recycling
4. Design for upgradability

For this annex the main focus is on the energy consumption of the DPF during the usage phase of the lifecycle. Energy in the manufacturing and recycling phase is comparatively small. Other environmental impacts such as mercury content of LCD display backlights and recycling of DPF materials are covered in detail in the PC preparatory study. [8] .

At this stage the target product group of this annex of the study derived from initial research and Stakeholder consultation are:

- Digital Picture Frames

The main criterion under review in the study is the in-use energy efficiency of these products. 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)
- Power management (the device is always in the lowest power consumption mode for the required functionality) Power management can encompass:
  - Timer control facilities
  - Automatic standby feature

The main scope of the study concerning the DPFs is on the power consumption during use at the consumers' premises. As it is known from other studies focussed on electronic media products, the consumer behaviour and the energy saving options preinstalled at the factory level are much more important for the whole life cycle energy consumption than the production, distribution and the recycling phase.

1.2.3 Technical Parameters

The components consuming the majority of the power are for

Digital Picture Frames

[8] Lot 3 Personal Computers (desktops and laptops) and Computer Monitors 6.3.7.1, 7.1.8, 7.2.7

- Backlighting
- The processor,
- Power supply

A DPF is a type of LCD Monitor with an integrated small and simple computer. Most of the components are similar to the components of an integrated PC, just a little bit simpler because they only have to perform a single task. All electronic components of the DPF are usually located on one PCB.

The central processing unit (CPU) in a DPF is similar to the CPUs used in small, electronic handheld games.

The DPF has some ROM memory chips to store the operating system and some Flash memory to store the pictures, the settings and some of the operating software when in on-mode. ROM and Flash memory are persistent, so data isn't lost when the device is in off-mode.

A common type of the display is a 640x480-pixel, passive-matrix liquid crystal display (LCD) with a viewing area of about 13 by 18 cm. Bigger displays are entering the market as the 'bow wave' of the LCD screen demand dies down. The type of display used in DPFs is thin enough to provide a frame that isn't much thicker than an ordinary non-digital picture frame. Most DPFs display the pictures in 12-bit colour, which means that approximately 4,100 different colours can be displayed on the screen. The main energy-consuming component of the DPF seems to be the backlighting. The backlighting technology is shifting slowly from fluorescent tubes to LEDs.

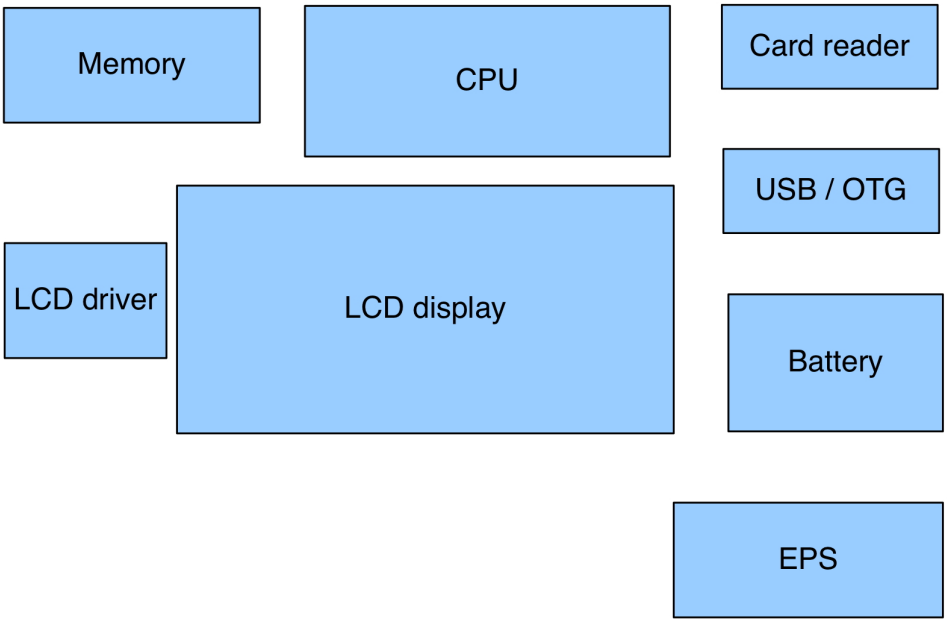
On some DPFs there is only a button that turns the frame on and off. Other functions are controlled by a remote control. Others have some of the buttons of the remote integrated into the casing, mostly on the backside.

The DPFs use an embedded operating system. Such OS systems were designed initially for devices like PDAs or STBs. The software installed gives a main issue of the energy consumption. Since auto-off functions are available but not common yet.

Almost every DPF is powered by an external power supply. Due to the regulation published recently the efficiency of the EPS is an issue that is not covered by this study[9].

[9] COMMISSION REGULATION (EC) No 278/2009 of 6 April 2009

Components of a DPF



The calculation of the energy consumption of DPFs is difficult at the moment since the DPF market covers several niches. Energy consumption in On-mode starts at 3.2 Watt in the group of 16 - 20 cm displays and goes up to 70 Watt for Displays with diameter of 81 cm. Some devices mainly those that offer GSM and DECT as a feature are always in On-mode.

Another issue of the DPFs is that for future products the addition of components to provide PC monitor functions would open a loophole for the circumvention of any measures concerning monitors. For TV-sets the availability of DPF with DVB-T tuner incorporated is a fact already. They are marketed as DPFs not as TV-Sets.

The Commission assessed a number of product groups according to the criteria laid down in Article 15 of the Ecodesign Directive, notably:

- the product group represents a significant volume of sales and trade within the Community,
- the product group has a significant environmental impact within the Community resulting from the energy-using products during their life cycle,
- the product group presents significant potential for improvement in terms of its environmental impact without entailing excessive costs.

The product groups prioritised by the Commission fulfil the sales and trade criteria of indicatively more than 200,000 units a year within the Community. Energy-using products from the domestic, tertiary and industrial sectors are covered. This criterion is a yes/no question, as the impact of the number of units per product group directly influences the assessment of the second criterion, the environmental impact.

Regarding the third criterion, the significant potential for improvement in terms of the environmental impact of the product groups and the potential for ecodesign measures were considered to set priorities: An important potential for ecodesign measures is given by a high potential for energy savings (indicatively > 20%). Further important ecodesign measures may comprise reduced weight/volume of a product, optimised product design for the consumer's use phase, modularisation of a product to ease maintenance and recycling or the extension of the product's lifetime. Existing third country specifications, such as energy labelling, MEPS, Energy Star and/or eco-labels, indicate

important potential for improvement and a wide disparity in the environmental performance of the energy-using products with equivalent functionality.

The four product groups discussed in this study reflect these criteria and in the case of the DPFs will help to close a potential loophole within the scheduled computer measure and TV Regulation[10].

That loophole is created by the product genre, DPF which is not sold as a PC monitor or a Television. The device is sold specifically as a display for digitally stored photographs (”pictures”) but could have the added feature of an analogue or digital PC data input, allowing it to function as a PC monitor, or could have a TV tuner, allowing it to function as a TV.

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 Picture Frames

and are approved by internationally recognised standardisation bodies, or where relevant industry associations. The internationally approved standards often share ratification and are published as European Standard / Norm (EN) and International Electrotechnical Commission Standard (IEC) under a common reference number and title.

A typical test regime for the devices (covered by the study) 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.

European and/or 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.

IEC 62087:2002 / EN 62087:2003 “Methods of measurement for the power consumption of audio video and related equipment”

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.

For on mode and standby mode the conditions and methodology quoted in IEC 62087 should be used. For metering both on mode and standby mode the methodology in IEC 62301 should be used. Both standards IEC 62087 and IEC 62301 are under review. The latter will be formally published as an updated standard in 2008.

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. As a reference for tests available, the tests made by Stiftung Warentest[11] concerning are displayed below with their relevant results.

[10] Preparatory Study on Personal Computers (desktops & laptops) and computer monitors, www.ecocomputer.org
COMMISSION REGULATION (EC) No 642/*2009* of 22 July 2009 with regard to ecodesign requirements for televisions.
[11] Stiftung Warentest , Berlin (www.test.de)

Environmental Characteristics

The tests are carried out for all specimens in the same normal environmental conditions (temperature and medium humidity).

The same test image is used for all specimens.

All specimens are in a steady, stable state (after approximately 10 minutes)

Power

An active power meter is used for the measurement of the power consumption of each specimen in the following modes:

- off mode
- standby mode
- on mode for playback operation

Indication of an automatic shutdown, if any.

Power Switch

- Is there a mains switch available that separates the sample completely from the grid?
- Where is it placed? Is it easily accessible?

The assumptions for the calculation of the power consumption within the product's life cycle are:

- Operation of 6 hours per day and a life cycle of 6 years (20 Cent/kWh)

1.4 Existing Legislation and Voluntary Agreements

1.4.1 European Legislation

There are five relevant European Community Directives:

- Directive 2002/96/EC (WEEE)

The WEEE Directive requires Member States to ensure that WEEE items are collected and treated at end of life. For DPFs the Directive requires that (i) at least 75% recovery by the average weight in tonnes of the equipment and (ii) at least 65% reuse and recycling of components.

- Directive 2002/95/EC (RoHS)

The RoHs directive, 2002/95/EC, requires Member States to ensure that new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE). Regarding DPFs, the limitation placed on mercury, used in the compact fluorescent lamps for illuminating the LCD screen, is relevant.

- Low Voltage Directive (LVD) 73/23/EEC

The Low Voltage Directive (LVD) 2006/95/EC seeks to ensure that electrical equipment within certain voltage limits both provides a high level of protection for European citizens and enjoys a Single Market in the European Union. The Directive covers electrical equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current.

- Electromagnetic (EMC) Directive 89/336/EEC, amended by Directive 92/31/EEC

The EMC directive limits the emission of electromagnetic radiation from electronic products. Countries outside the EU have similar regulations although the detailed requirements may differ. From the perspective of this work the EMC directive is not critical.

- Commission Regulation 1275/2008 implementing Directive 2005/32/EC. Ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment

The latter applies to the standby and off mode power consumption of electrical and electronic household and office equipment and as a result applies to all the products under study "unless inappropriate". It sets maximum power consumption allowances depending on the functions enabled while in standby and off-mode which come into effect in 2010. The requirements are then tightened further in 2013.

The Regulation specifically defines standby and off mode "which must be available for equipment "unless inappropriate":

- 'off mode' means a condition in which the equipment is connected to the mains power source and is not providing any function; the following shall also be considered as off mode:

  (a) conditions providing only an indication of off-mode condition;

  (b) conditions providing only functionalities intended to ensure electromagnetic compatibility pursuant to Directive 2004/108/EC of the European Parliament and of the Council

- 'Standby mode(s)' means a condition where the equipment is connected to the mains power source, depends on energy input from the mains power source to work as intended and provides only the following functions, which may persist for an indefinite time:

  - reactivation function, or reactivation function and only an indication of enabled reactivation function, and/or

  - information or status display.

And the requirements are:

	Off-mode	Standby mode	Standby mode with information display
2010	1.0W	1.0W	2.0W
2013	0.5W	0.5W	1.0W

In 2013, unless inappropriate, equipment must switch to a standby or low power mode after the shortest appropriate period of time.

While it is not clear what is meant by "appropriate", a discussion of the legal definition is not relevant to this study. Instead rather than pre-empting ecodesign options with Regulation already agreed, the various power modes for the products, which may include an overlap with standby, is better assessed on a case by case basis. How Regulation 1275/2008 is appropriate can then be re-examined when a conclusion is reached for the products in the study.

- Commission Regulation 278/2009 implementing Directive 2005/32/EC. Ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies (EPS)

The regulation sets maximum power consumption levels for EPS in no-load condition and an average power conversion efficiency when in active mode. This will apply to any products in this study that are sold with an external power supply. Because the power efficiency of the device includes the EPS, any losses resulting from the EPS must be taken into account during design. The ecodesign requirements come into effect in 2010 and are tightened in 2011.

The definitions used and the ecodesign requirements are too complex to be listed concisely and informatively. However, since the EPS is contained in a physical enclosure separate from the primary load the ecodesign cross-over is relatively simple.

The general application of these directives and regulations to the DPF product follows the related detail for PC monitors given in the PC preparatory study. [12]

1.4.2 Eco-Labelling and Third Country Programmes for energy efficient A/V products

Country	Programme	Scope	Summary of requirements				Program type	Date
			On (W)	On-idle (W)	Standby (W)	Other		
USA	ENERGY STAR	Digital Picture Frames		2 (sleep)	1 (off)		Voluntary label	2009/2010

US EPA announced new ENERGY STAR requirements for computer monitors, digital picture frames DPFs and other displays (March 2009). Within the EU-Energy Star agreements this programme is valid for the EU as well, but only for office equipment and not for household appliances .

According to EPA[13]: "Digital picture frames offer an impressive opportunity for energy savings. It is estimated that 9.3 million digital picture frames were shipped in 2008 and by 2015 the number could more than double in the USA. Savings from digital picture frames represent about 10 percent of the total potential savings in this product area. By far the majority of DPFs is sold for household purposes. Nevertheless some are used in showrooms and shops to illustrate product features of the products displayed. It is difficult to divide in this area between DPFs and monitor-integrated PCs.

The specification for displays less than 30 inches diagonal will be effective October 30, 2009.

1.4.3 Other Legislation

There is no further national, EU or third country legislation on Digital Picture Frames.

[12] Lot 3 Personal Computers (desktops and laptops) and Computer Monitors: 4.3.4
[13] EPA Issues: New Requirements for Energy Star Computer Monitors, Picture Frames (Release date: 03/30/2009)

2 Task 2: Economic and Market Analysis

2.1 Introduction

The analysis for each segment is divided into two topics:

- The actual market situation and market potential
- The market trends

Digital picture frames (DPFs) entered the market in 2005 when manufacturers of smaller displays lost their market potential since the demand for small size displays decreased as the laptop and monitor sizes increased as well as the diameter of portable TV-sets. At the outset, marketing of the displays did not meet consumer demands since picture quality was inferior to the picture quality consumers were used to from ordinary photo prints. Focussing on several niche market segments increased the market success of DPFs. Sales peak in the pre-Christmas season.

2.2 Generic Economic Data

Since DPFs are a new product segment, they are not covered separately by a specific number of the existing ProdCom and EU Trade Statistics but they are included in other ProdCom categories such as computer monitors.

2.2.1 EU Production

Digital Picture Frames

This product was “invented” to provide a “second life” for the manufacturing lines that became obsolete when the demand for LCD displays shifted from rather small to larger displays. Instead of disposing of the manufacturing equipment the line was recycled to produce the new product around 2004/5. In 2005 the first DPFs came onto the market, but with limited success. In Europe the marketing of the first DPFs was quite unsuccessful due to the inferior picture quality of the displays. With the help of some European importers, who had access to brand names well known in Europe, the Chinese vendors ordered improved products from their local manufacturers. The product became more visible to European consumers in 2007 and the pre-Christmas sales in 2008 created a real breakthrough for DPFs.

The majority of DPFs are “Made in China” or “Made in Taiwan” since manufacturing equipment for small and medium displays[14] was shifted from Japan to reduce manufacturing costs. Declining demand for small displays lead to decreasing prices. The average price drop for 2009 is estimated to be 5% in 3 months. Even support from the Chinese government that promoted rural sales of mobile electronic goods in the Chinese domestic market could not help prevent the price reductions. The actual struggle of Japanese suppliers makes the situation even more price competitive.

When companies manufacturing medium-sized LCD-panels tried to clear their overstock this created some pressure on the price level. This pressure increased when designers of netbooks, a market segment that absorbed some amount of medium sized displays in 2008 decided to use bigger LCD-displays for their products. Suppliers that have product portfolios with a focus on smaller-sized displays come under massive pressure. In January 2009, the price of 7-inch panels declined, on average, by 13%, while the price of 8-inch panels fell by more than 22%.

As a result of improved supply organisation of several suppliers and improvements in the management of panel production and capacity utilisation the recent price declines could be reduced in the second quarter of 2009. Some panel manufacturers closed their lines earlier this year. As far as it is known to date the manufacturing resumed in May 2009.

[14] Small displays cover screens up to 8 inches, medium size range from bigger than 8 inches up to 30 inches, large are above.

There is no manufacturing site for small and medium panels and screens, as used in DPFs, known within the EU-27.

2.2.2 EU Sales

The sales of DPFs within the EU-27 augmented within a very short period. Entering the market in 2005 with a few samples of more or less known brands, in 2006 several established brands started to find their niches, doubling or even tripling the sales numbers in the following years. Whilst only a few market observers saw the market potential of these devices in the beginning the success now is overwhelming and DPFs became a real application for small and medium sized LCD displays.

According to EICTA the total sales of DPFs in EU-27 was 5.72 million devices in 2008, with the biggest single markets in Germany (1,274,243 devices), UK (992,866 devices) and France (865,514 devices). In recent years most DPFs were purchased as a present so the biggest sales period is about one month before the Christmas. As an example, according to GfK, 450.000 digital picture frames were sold in Germany only within the last 4 weeks before Christmas 2008. This was an increase of 200% over the pre-Christmas sales of 2007. For other member states similar trends are known, but exact numbers are not available.

2.2.3 EU Trade Statistics

Extra-EU Trade

Since DPFs are not manufactured within EU-27 all such devices are imported into the EU. DPFs are available as no-name products, as branded products using well-known, established European brands and as private label products. Trading companies use private labels as their own brand names. The same manufacturers that supply the well-known brands make some of the private labels; smaller manufacturers that have no own brand name and marketing power make some of the others. The lowest quantity known for private label products is a lot of 25 pieces. These low quantities are only co-branded with a private label. The registration of these DPFs with the respective recycling scheme to fulfil the requests of the Waste Electrical and Electronic Equipment Directive 2002/96/EC are provided by the importer using the main brand

All DPFs are imported from East Asia. Since DPFs cover several market niches, no specific statistical data is available for this particular product group. ProdCom includes DPFs within the no. 32.30.20.49 of Computer Monitors, colour, not incorporating television reception apparatus (excl. with cathode ray tube and those of a kind solely or principally used in an automatic data-processing machine of heading 8471) Flat panel video monitor, LCD or plasma, etc, without tuner (colour video monitors) (excluding with cathode-ray tube). The respective tariff number for customs purposes is 8528 59 90.

Other segments within the ProdCom statistics could cover combo products that add additional features to the DPFs main features. If there is a DVB-T tuner added, it's a TV-set. Customs clearings regard mobile DVD-players with screen on one hand side as a DPF, but tax it as DVD-player.

Concerning DPFs there are no separate data available from ProdCom or other trade statistics in the EU.

Intra-EU Trade

There are no statistical data of Intra-EU trade of DPFs available.

2.3 Market and Stock Data

2.3.1 Study Approach to Gathering Market and Stock Data

Digital Picture Frames

Sales data for DPFs was sourced from EICTA for 2008. From iSuppli Corporation [15] data of actual production in 2008 was available as well as a forecast to 2013. Using both sources provided data for a forecast to 2013 to be made. Similar data are distributed by InStat [16]. With a dynamic development of the growth rate given by the iSuppli data a forecast up to 2020 was developed. To generate stock data from 2008 to 2020 an estimation of sales in 2007 was made on the basis of the information that sales in 2008 tripled. Referring to discussions with stakeholders DPF sales in 2005 and 2006 were not considered relevant.

Table 1: Digital Picture Frame Sales EU27 2008 (Source: EICTA)

EU 27 State	Volume (in pieces)
	2008
Austria	108,019
Belgium	131,844
Bulgaria	26,715
Cyprus	ND
Czech Republic	89,399
Denmark	121,774
Estonia	10,006
Finland	113,734
France	865,514
Germany	1,274,243
Greece	67,381
Hungary	59,723
Ireland	34,122
Italy	330,292
Latvia	8,942
Lithuania	24,897
Luxembourg	4,007
Malta	ND
Netherlands	313,809
Poland	204,153
Portugal	150,435
Romania	74,866
Slovakia	20,713
Slovenia	18,612
Spain	449,753
Sweden	224,179
United Kingdom	992,866
Total EU27 (units)	**5,720,000**

ND = No Reliable Data

[15] iSuppli Consumer Platforms Q1 2009 Market Tracker (www.isuppli.com)
[16] InStat (www.in-stat.com) is a part of Reed Elsevier.

Table 2: Forecast Digital Picture Frame Sales EU27 2008 (based on EICTA and iSuppli data)

	2008	2009	2010	2011	2012	2013
World (iSuppli [17])	14,838,000	17,509,000	23,637,000	31,201,000	40,250,000	50,312,000
Growth Rate		1.18	1.35	1.32	1.29	1.25
Sales forecast [18] EU-27	**5,720,000**	**6,749,600**	**9,094,800**	**12,012,000**	**15,501,200**	**19,390,800**

For a forecast of the further development of the stock of DPFs in EU-27 the assumption of a life time of six years [19] was made, according to the information given by Stiftung Warentest. DPFs entered the market in 2005. Sales data for this and the following year are not available. Data available from EICTA start with the year 2008. With data published for 2008 by Photoindustrie-Verband e.V. and GfK these sources mention that sales of DPFs tripled in 2008 so the assumption for 2007 is 30% of 5,720,000 (2008): i.e. 1,716,000. Due to a potential saturation of the market a reduced growth rate from 2011 is expected with a sales peak in 2018. Assuming a six-year lifetime for DPFs, the sales in 2007 will be replaced by 2013. In the following years, an increasing number of DPFs would be replaced when reaching their end of life.

Table 3: Sales, Replacement and Stock Development of DPFs in EU-27 [20]

Year	Sales (forecast) EU-27	Replacement	Stock
2007	1,716,000		
2008	5,720,000		1,716,000
2009	6,749,600		7,436,000
2010	9,094,800		14,185,600
2011	12,012,000		23,280,400
2012	15,501,200		35,292,400
2013	19,390,800	1,716,000	49,077,600
2014	23,269,000	5,720,000	66,626,600
2015	26,759,300	6,749,600	86,636,300
2016	29,435,200	9,094,800	106,976,700
2017	30,906,900	12,012,000	125,871,600
2018	31,215,600	15,501,200	141,586,000
2019	29,654,800	19,390,800	151,850,000
2020	26,689,300	23,269,000	155,270,300

Table 4: Expected development of the sales growth rate from 2014 until 2020

Year	2014	2015	2016	2017	2018	2019	2020
Growth rate	1,20	1,15	1,10	1,05	1,01	0,95	0,90

The following risks should be noted with reference to this calculation:

1) DPFs sold will be stored in the cupboard and never used. This would reduce the active stock relevant for energy consumption.
2) DPFs will not be recycled but used in the children's room, weekend bungalow or similar. This would reduce the replacement and could increase the active stock.
3) Other display devices as PC monitors or TV sets would become so inexpensive that they could replace the DPFs.

The fact that 155 million DPFs would represent one DPF for one third of all EU-27 citizens illustrates only the average. Several households could even use more than one DPF in different rooms.

[17] iSuppli Consumer Platforms Q1 2009 Market Tracker (www.isuppli.com)

[18] Based o the growth rate given by 11)

[19] Source: Stiftung Warentest 2008

[20] Sales, replacement and stock numbers are independent from size and size related average power consumption. Rates of the respective development are not predictable, since they are dependant on too many influences. It is expected that higher power efficiency of new devices would be "4absorbed" by bigger screen sizes.

Additional features could even provide additional benefits for the users and open new market segments. At present the memory of the DPF is integrated or added with a USB stick or a memory card and so it is limited. Future DPFs could be equipped with Wi-Fi or LAN and would be integrated into the in-house data network and would provide access to the main server with an immense picture capacity. As the preparatory study for TV illustrates[21], TV stock increase is expected from 303 millions in 2005 to 429 millions in 2020. The respective preparatory study for computers[22] illustrates that the computer stock is expected to rise from 355 millions in 2005 to 742 millions in 2020. Arguments that DPFs are potentially only a fashion product were proven to be true, but in a different way than expected: now the style of the frame became a fashion issue and no longer the product itself. This development will even increase the sales numbers since the fashion could change from season to season, increasing the pressure for fashion related customers to buy a new device. Recent publications [23] see the fastest growing group of customers as female customers who buy the DPFs to display the pictures they made with their compact digital cameras. Female customers are a key target group for the marketing of DPFs.

2.3.2 Commercial Market Research Data

Digital Picture Frames

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

Accurate estimates of 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 products distributed by network operators requires careful analysis.

2.3.3 Data – Assumptions and Qualifications

Digital Picture Frames

Since sales data for DPFs are only available from time to time and the DPFs are covering so many different niches there is only a limited possibility to deduce the sales numbers and stock data for DPFs.

2.3.4 Stock Data

Digital Picture Frames

From the sales data available it is clear that the sales and trade volume of DPFs alone is significantly higher than the indicative threshold number of 200,000 units/year, stipulated in the Ecodesign Directive 2005/32/EC for an Energy-using Product measure.

[21] Preparatory Study on Televisions, www.ecotelevision.org
[22] Lot 3 Personal Computers (desktops and laptops) and Computer Monitors Reference see footnote 10.
[23] “Glänzende Aussichten im Rahmen” in: Financial Times Deutschland (www.ftd.de)

2.4 Market and Production Structures

2.4.1 General Trends

Digital Picture Frames

Since DPFs came into the market as an option for LCD-panel manufacturers to sell products from their manufacturing lines that had become obsolete (i.e. for TV-Sets, PC-monitors and similar devices), the main purpose of DPFs from the manufacturers' side is to fill the gap that exists on the demand side. Since monitors, TV-sets, Notebooks and Netbooks are becoming larger; the size of DPFs is following this trend. As mobile GPS systems are increasing the size of their screens, DPFs are in a "sandwich" position between GPS systems and the TV / Monitor / Notebook segment. After computer and TV screens the DPF is becoming the 3rd display in most households.

The market for DPFs is a multi-niche market and the trends visible during the last few months indicate significant seasonal sales peaks, with the main peak before Christmas.

2.4.2 Structure of the Supply side

- Categories of suppliers and supply chain for DPFs

The main sources of DPF displays are several manufacturers of smaller scale LCD displays. Most of these are located in Mainland China. The manufacturing equipment is partially imported from former manufacturing sites in Japan and Taiwan. Several companies in China provide the system integration and assembly of DPFs on a contract manufacturer or OEM basis.

Most of the brand owners do not operate their own manufacturing sites, but order directly from the factory or via vendors or sales agents. The exact structure of the supply chain is changing rapidly due to the highly dynamic market, including an enormous number of small niches for the product.

2.4.3 Competitive Analysis of the Market

There is a growing number of companies bringing DPFs to the market. Every brand available could be used for the promotion of DPFs. There are camera brands, film brands, electronics brands, mostly known for white goods. Models are changing rapidly, with new models coming onto the market every month. Shelf life of a DPF could be as short as 3 months. The market is expected to reach maturity around 2018. Market shares of each brand are difficult to calculate. The same product could be available in one European market under one brand and in another under a different label. Even the same brand could source a product with the same name printed on it from a different vendor. Margins in this area vary from very low to satisfactory.

2.4.4 Average economic Product Life-Cycle

Since DPFs entered the market only in 2005, no average Product Life-Cycle data are available. Stiftung Warentest did their product tests calculating the life-cycle of a DPF at about six years.[24]

[24] Stiftung Warentest 2008 Test 11/2008

2.5 User Expenditure Base Data

2.5.1 Average Consumer Prices (incl VAT and in Euro)

Digital Picture Frames

Consumer prices for DPFs have been decreasing since the end of 2008, depending on the reduction of panel costs and actual market situation, with a significant overstock of small panels and displays.

For this study, consumer prices for DPFs have been checked in UK, France and Germany in May 2009. Due to stock clearing sales and high pressure from new products with additional features prices could decrease further.

Table 5: Table for average consumer prices in UK, France and Germany in 2008

Size / Price	**17,78 cm (7")** **Small**	**20,32 cm (8")** **Small**	**25,40 cm (10")** **Medium**
UK € (£)	43.97 (40.80)	83.23 (77.22)	123.95 (115.00)
France €	65.00	96.50	119.00
Germany €	64.50	98.50	146.50

The average power consumption of DPFs available at present are calculated on the basis of test results from Stiftung Warentest. Stiftung Warentest selects the products according to GfK data and operates its own market survey including the hand out of specific questionnaires for the manufacturers/importers known as relevant to the market. As a result to responses and the GfK data the selection of the products to be tested is made. Concerning the DPFs Stiftung Warentest[25] published a first version of the test including all devices tested. For a second publication provided online only, they focused on energy efficiency and reduced the number of products by excluding devices that were insufficient (mangelhaft) for other reasons than efficiency. As it is expected that the products excluded will not be available on the market soon after the publication of the test results, they were not part of the calculation basis for the average power consumption in this study. The average power consumption of the DPFs calculated on this basis is 10 Watt in on-mode.

2.5.2 Electricity Rates, Water Rates, Fossil Fuel Rates

Running costs for the products are dictated by the price of the electricity used. For details see: Table 4 in the main report.

2.5.3 Interest and inflation rates

For details see: Main report.

2.5.4 Installation Costs

Not applicable.

2.5.5 Consumer Prices of Other Consumables

Not applicable

[25] Stiftung Warentest: Test 11/2008 and www.test.de/themen/umwelt-energie/test/-Spargeraete-Digitale-Bilderrahmen/1745368/1745368/

2.5.6 Repair and Maintenance Costs

The replacement cost of many consumer electronic products 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 an electronic device costing up to 150 Euros will be repaired in its lifetime. Instead of a repair, a replacement of failed devices is the common practice with importers of such items. Costs for storage of spare parts needed for repair is far beyond the budget of importers. For guarantee purposes an oversupply of devices at no cost is common. Therefore there is no repair solution for DPFs available, since the price of most DPFs is quite low compared with potential repair and handling costs.

Since DPFs – as most consumer electronics – are produced not in a continuous manufacturing process but on a lot-by-lot basis, the manufacturers do not keep or provide any spare parts for a repair of these devices. Importers who have to fulfil their guarantee have to keep sufficient stock for replacement or have to replace defective devices by a model of a following generation.

As new DPFs will offer additional features, larger size and more elegant frame designs, older DPFs could be replaced before they reach a lifetime of six years. As with the early generations of personal computers that were moved to the children's rooms or the grandparents flat to gain a second life, early DPFs will be moved to other rooms. Since a DPF does not take much space, an accumulation to up to one DPF per room is not impossible. Some unused DPFs could be stored in the cupboard as it happens with several other small electronic devices. Due to the short time the DPFs are available on the market, a detailed picture of the way customers will handle the devices in the long run is not available yet. Some DPFs could be used longer than the estimated six years, others could be used for a much shorter time.

2.5.7 Disposal Tariffs/Taxes

A product-recycling scheme specifically for DPFs is not known. The end of lifetime disposal costs for DPFs are the same as for other screens. End of life disposal costs for electronic devices depend on the recycling procedure to be implemented in each country. The costs are usually quoted on a per tonne basis. Due to the different procedures for recycling of consumer electronics implemented in each country the cost may vary from country to country. The prices in Germany used to be the lowest due to high competition in the market.

As a consequence of the financial and economic crisis the market price for most recycling fractions deteriorated. Where recyclers could sell some fractions at reasonable prices, they have to pay now to get rid of the material. Mixed plastic fractions are almost unsalable and are stored or used for fuel. The recycling costs for manufacturers/importers almost tripled within the last 12 months. At present the recycling costs for a DPF of 750 grams should not exceed 1.20 Euro.

Due to the batch-wise manufacturing of DPFs a wide variety of products and components are on the market and many products vary significantly even if they are marketed under the same brand and product name. A refurbishing of products or components is more or less impossible under the given circumstances with no manufacturing knowledge concerning low cost LCD displays available in Europe. As a result only down-cycling of the material is common.

3 Task 3: User Behaviour

3.1 Introduction

DPFs are novelty products, they are unessential for daily life. The reasons for purchase will vary from buyer to buyer. Since they are sold at different locations and bought for different occasions, it will be difficult to focus on the consumer to take the energy consumption of these devices into account.

3.2 User Information

3.2.1 Digital Picture Frames

Most DPFs are bought as presents for friends or relatives. The electronic components and energy efficiency are likely to be only a marginal reason for a specific buying decision. The main purchase decisions are likely to include price, size and design of the actual frame as well as the availability of the DPF. As Christmas is the biggest season for presents in Europe companies sell 70% of their DPF volume during the few weeks before Christmas. For example the pre-Christmas sales of all brands in Germany was 450,000 DPFs in 2008.

A DPF is an ideal present for older people who are not used to PCs. If they get the installation completed by relatives, they will use a DPF with their DECT phone as well as a DPF with GSM module. A GSM module provides easy picture updates for grandparents. A second and growing segment of buyers of DPFs that the marketers are now focussing on are women who buy the DPFs to display the pictures they made with their digital compact cameras. These customers focus more on the style of the frame than on technical details. Because of the falling price of DPFs, buying them will be even more an ad hoc/spontaneous decision at the point of sale and will not be pre-determined by consideration of their energy consumption.

Devices for the target groups mentioned above have a significant advantage if they are more or less intuitive to handle and self-explanatory. Such customers do not like extensive manuals. So any information about the energy consumption and how to keep energy costs low should be printed on the outside packaging. This reduces the amount of information to a few lines only.

The information on the packaging could be: *“energy consumption in on mode: x watts”*

3.3 User Behaviour in the Use Phase

3.3.1 Digital Picture Frames

Some devices have no option to switch them off. To switch-of such devices consumers would have to unplug them. As only a few consumers are expected to do so, most of these displays will run 24 hours a day. There are no extensive studies available that explain the usage patterns of DPFs in Europe in details. For testing purposes and respective recommendations for consumers Stiftung Warentest in Germany assumed 10 hours of use per day for all devices that have a standby or off mode. This comprises the greater majority of DPFs in the market today.

There are devices that provide an integrated software timer, which provides an option to switch to stand-by after a specific operation time. The customer has to set-up the time manually. As most customers will prefer a plug and play solution, they will not change the existing factory set-up of the DPF. This habit provides an option to provide a factory set-up that switches-off the device two hours after starting the device. Customers, who dislike the factory set-up would have the option for a manual override or adjustment of their preferred operation time. It is expected that most will not do so, but accept the factory set-up. Two hours is common to view pictures. If a user wants to view them for a longer time he could override the factory setting or re-start the device.

Usage patterns of DPFs with integrated extra functionalities as DECT, GSM, Clock or home weather station may differ, but a factory set-up providing a switch-off (in fact a switch to stand-by) after two hours would not affect the customers' use of the product significantly.

DPFs with a DECT module integrated are operated as a handset that connects via GAP functionality to the base station of a cordless phone. Utilising the CLIP feature, the picture of a caller that is registered in the address book of the DPF will be displayed when he or she is calling.

Several DPFs with an integrated DVB-T module are equipped with a rechargeable battery. They could be operated as a mobile TV-set and as a picture frame when recharging.

DPFs with VGA module are dual-use products. Since there are only a few of these products available as yet, there is no information about the characteristics of use available. The product could be used as a monitor and similar to a screen saver it will display pictures if and when the PC that it is connected to is switched-off.

As additional features such as WI-FI connection to a home server system that stores all the pictures and videos to be displayed by such a DPF are expected to be available soon, there is an option whereby such DPFs could be used as video monitors in several rooms of a house. Use patterns of such devices will come closer to present TV-sets. Such users would override the two hours factory set-up manually.

3.4 End-of-Life Behaviour

3.4.1 Digital Picture Frames

Stiftung Warentest expects a life span of 6 years for digital picture frames. Since the devices came onto the market in 2005 only devices that were broken or faulty have been disposed of since then.

There is an assumption that digital picture frames up to the size of 7" tend to be disposed off via ordinary household waste and only larger sizes would be supplied to a recycling system by the end user. At present waste collectors and partners of the "green point" are very reluctant to provide any data about the correct or incorrect recycling/disposal of small electric/electronic devices. There are estimations that only 10% of small devices are disposed of correctly. Up to 60% of DPFs could be disposed of with household waste. Waste processing plants will not sort them out, but dispose of them with the other garbage. Only partners of the "dual system/green point" or similar operator have the opportunity to sort the collected material and provide this for any recycling.

From other studies as the SSTB study (ecostb)[26] it is known that a number of devices that are still in good working condition, but outdated by new items providing more features, are simply stored in the cupboard (i.e. delayed disposal).

Discussions with manufacturers/importers about the potential for product recycling, re-using or refurbishing showed the following problems:

- DPFs are fashion products that cover a growing numbers of niches in the market. So there are many variations of DPFs available. Licensing and branding of products may differ in different EU countries. So branding of the products and product names could be identical, but products may differ as well. Technological development is fast and as a consequence several electronic components used for the operation of the display would not be available after their production cycle is finished.
- The resale/refurbishing that is known from notebooks and mobile phones provide these products for re-use in third world countries. This option is not available for DPFs and such an option seems impractical due to packaging and transport issues. The screen of mobile phones and notebooks could be protected easily for transport purposes. Covering the screen of a DPF is more involved posing a barrier.

[26] Study on Simple Converter Boxes for digital television (Simple STBs), www.ecostb.com

4 Conclusions

For digital picture frames it is significant that the screen size of mains powered DPFs is increasing as the price for the implemented panels drops due to reduced demand from manufacturers of devices that could be sold at higher prices. DPFs started as a second market to other electronic devices that are more trendy or needed by the end customers. While they are still in the “second row” they make use of the technological improvements concerning energy efficiency; for example, a switch is being made from fluorescent backlights to LED backlighting only shortly after or even in parallel with other devices such as notebooks.

For DPFs only rudimentary information about the use of the products is available. Since most of the items are purchased as presents, it would be difficult to convince the buyer of such a product to take account of the energy consumption of the device when buying it. Since a large number of DPFs will be given to grandparents or other persons who may not be familiar with such IT products, any measure taken into account to reduce the power consumption of DPFs during use, should be easy to handle by a person who is not familiar with technical equipment, i.e. the ex-factory operation mode should be the most energy efficient possible.

Screening of a potential impact of optional measures on the power consumption

Product	EU-27 stock (Units in 2020)	Power Consumption on-mode (Watt)	Average use pattern on-mode (hours/day)	Power consumption - standby (Watt)	Average use pattern stand-by (hours/day)	Estimated energy consumption per product (KWh/year)	Total stock energy consumption (TWh/year)
Digital Photoframes							
Scenario 1	155,270,300	10	24	1.0	0.0	87.6	13.60
Scenario 2	155,270,300	10	10	1.0	14.0	41.61	6.46
Scenario 3	155,270,300	10	2	1.0	22.0	15.33	2.38

The expected life cycle of DPFs is six years. Any measures implemented to be effective before 2012 will help to have almost the entire stock of DPFs replaced by 2020. The stock expectation is 155,270,300 devices for 2020.

The calculation of the impact on energy consumption is based solely on the implementation of an auto-switch-off that will switch off the device after 2 hours as a factory set-up of an integrated timer. As the manufacturer of the device could implement this solution during the design/programming phase of a DPF, the cost impact for the manufacturing process should be very low. Since there is no additional hardware needed and in fact no demand for any hardware change visible, there should no bottleneck that could be an obstacle for manufacturers.

The average on-mode power consumption of existing DPFs of 17-20 cm in diameter is 10 watt. Extremely large DPFs available on the market have a diameter up to 82 cm and consume about 70 watt in on-mode, but sales expectation for these DPFs is about 1-2,000 pieces in the near future.

Some devices are used in a 24/7 operation, due to having no standby option or a switch. These products are not included in the calculation. Including them would move the energy consumption calculations closer to scenario 1. The average standby consumption of DPFs is about 1 Watt at present. For the year 2020 a **standby** consumption of **1 Watt** is calculated is likely to still be the case given that DPFs will display other information (weather, time, temperature etc). The daily usage pattern used by Stiftung Warentest is 10 hours in on-mode per day.

There are 3 scenarios calculated with a stock forecast for 2020 of 155,270,300:

1) 24 hours/day in on-mode
2) 10 hours/day in on-mode and 14 hours/day in standby-mode
3) 2 hours/ day in on-mode and 22 hours/day in standby-mode

The calculated power consumption for the 3 scenarios is:

1) 13.60 TWh
2) 6.46 TWh
3) 2.38 TWh

In case of an increasing size of DPF displays the impact on power consumption of a factory set-up with an auto switch-off after 2 hours implemented, is even higher than calculated with the existing average size of 18 – 20 cm.

The difference between scenario 2 and 3 is the saving potential of the recommended measure to implement auto-power down after 2 hours as the factory set value.