Additional Evidence on Sustainability Impacts That Occur During the Life Cycle of Televisions

A research report completed for the Department for Environment, Food and Rural Affairs by AEA Group and The Centre for Sustainable Design.

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Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR
Tel: 020 7238 6000
Website: www.defra.gov.uk

Information about this publication is available from:
SCP&W Evidence Base
Defra
Zone 5D, 5th Floor, Ergon House
c/o Nobel House, 17 Smith Square
London SW1P 3JR

Email: scpevidence@defra.gsi.gov.uk

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Final Report to the Department for Environment Food and Rural Affairs

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P. Dolley, S. Ogilvie, D Goult, A. Wu
AEA Group
Harwell
Oxfordshire OX11 0QJ

T. Woolman
The Centre for Sustainable Design (CfSD)
University for Creative Arts
Farnham
Surrey GU9 7DS

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TABLE OF CONTENTS

Glossary

BAT	Best Available Techniques
BATTRT	Best Available Treatment Recovery & Recycling Technology
Blu-Ray	A high definition video storage medium
Cell (LCD or PDP)	LCD: A 'sandwich' consisting of an array , Liquid Crystal and filter PDP: Glass with the basic structure of a gas cell.
CO_2	Carbon dioxide
Comcode	Commodity Code HM Revenue and Customs use commodity codes define products, for example using a 10 digit Harmonised system (HS) code for imports http://www.uktradeinfo.com/index.cfm?task=TradeDataNotes
CRT	Cathode Ray Tube. A TV screen technology
DCF	Designated collection facility
Defra	Department for Environment, Food and Rural Affairs
DTI	Department of Trade & Industry
DTR	Digital Terrestrial Recorder
DVD	Digital Video Disc. A video storage medium
EA	Environment Agency
EOL	End-of-life
EPD	Environmental Product Declaration
EU	European Union
EU27	European Union (27 Member States)
EuP	Eco-design of Energy Using Products Framework Directive
FPD	Flat Panel Display
HD	High Definition. Video with higher resolution and quality
HDD	Hard Disc Drive
LCD	Liquid Crystal Display. A TV screen technology
Module (LCD or PDP)	LCD: Cell plus backlight and electronics PDP: Cell, structure plus power supplies, electronics and filter
MTP	Market transformation programme
NGO	Non-governmental organisation
OBM	Own Brand Manufacturer
ODM	Own Design Manufacturer A company which controls design and manufactures a product which ultimately will be branded by another firm for sale. An ODM owns the design and/or designs in-house the products that are branded by the buying firm, in contrast to a contract manufacturer.
OEM	Original Equipment Manufacturer A company which manufactures a product which ultimately will be branded by another firm for sale
OLED	Organic Light Emitting Diode. A TV screen technology.
PC	Personal Computer. Refers to laptop and desktop computers
PCS	Producer compliance scheme
PDP	Plasma Display Panel
RoHS	Restriction of Hazardous Substances Directive

RP	Rear Projection. A TV screen technology
SITC	Standard International Trade Classification A classification for trade statistics. Correspondence between the SITC Revision 4 codes and the Combined Nomenclature 2007 (CN 2007), Harmonized System 2007 and previous SITC revisions is given by Eurostat at http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL&StrLanguageCode=EN&IntCurrentPage=3
STB	Set Top Box. Converts a broadcast signal, eg digital terrestrial, satellite or cable, to TV video signal
TBBPA	Tetra brominated bis-phenol A
UNU	United Nations University
WEEE	Waste Electrical and Electronic Equipment Directive
WRAP	Waste & Resources Action Programme

Executive Summary

This report covers work to augment the developing Television evidence base initiated by Defra in 2007. Having identified gaps in the evidence, this study was commissioned to identify new sources of information, and specifically:

- Data describing current UK TV consumption trends, volumes and supply chain;
- Information addressing if and how UK consumption statistics (technology types, volumes and trends) are different from the EU25 averages assessed in EuP LOT5;
- Whether the scope of the product group definition affects the scale of environmental impacts. Here the EU25 average TV scope/definition was considered against the UK definition including amongst other products, video playing and recording equipment;
- The energy impact of active standby (currently a gap in the evidence);
- UK WEEE end of life management (domestic and exported).

To address these points, it was necessary to model the current and anticipated future energy consumption of TVs, review published information and to consult with stakeholders including representatives of producers, recyclers, trade associations, researchers and the Environment Agency.

A key finding is that consumer demand has resulted in a dramatic change in UK TV sales whereby in just five years, the sales of the once dominant CRT technology have dropped from 96% to 19%. LCD and plasma have become the dominant screen types in ever larger sizes. The rate of change is faster than that being experienced in the EU27.

While there is a higher intensity of televisions in the UK both in stock and usage terms, there seems to be little difference between the TV models entering the market with screen size projected to be similar and LCD technology dominant. Therefore, the technical analysis in the EuP will be valid in the UK scenario. Using the 2007 sustainable products consultation, this suggests that UK impacts of TVs per person could be as much as 4 times greater than Europe and could be set to increase to almost 5 times. However, with the updated data in the 2008 UK TV model snapshot, the impact is approximately twice the EuP prediction. Regarding convergence of Consumer Electronics and ICT products, the energy consumed by converged products compared to the individual products changes on a case by case basis. Modelling suggests this varies between a 20% reduction to a 40% increase in the worst case. Convergence is likely to increase energy consumption if the products are not equipped with adequate power management features. With power management, savings can be realised simply because it reduces the number of products left on unnecessarily. Power management in converged products including active standby, should also be required to prevent an increase in energy consumption by switching off internal services if they are being provided by external devices.

The change in screen types as seen in sales is, understandably, not being seen yet at end of life where 99.9% of UK TVs currently arising for treatment are CRTs. This situation is likely to persist in the short term but commentators predict a complete reversal by 2020 when most end of life TVs will be the newer flat panel display types. At the present time, the UK recycling industry has little experience of handling Flat Panel Displays (FPDs) although they are keen to point out that the few units arising are handled in compliance with WEEE regulations which means the manual and comparatively expensive task of removing LCD backlights. Process automation may be helpful in securing cost savings and resource efficiency benefits but what is clear is that recyclers are unlikely to invest in new plant unless they can be assured that a given process is deemed WEEE compliant by regulators.

Considering all TV types arising at end of life, information suggests that 10% are reused, 20% are exported and 70% are recycled in compliance with WEEE Regulations. Stories abound about waste electronics being exported to Africa and China but we have not found hard evidence of the UK being an exporter of such wastes. Nonetheless, from the European perspective the issues are considered sufficiently worrying for the Commission to consider developing specific, legally binding rules for environmental inspections of waste shipments.

The TV supply chain serving the UK market is dynamic in response to regional and global factors. The vertical integration once prevalent when CRT dominated, where producers had their own European based production plant, has returned following a period of outsourcing to suppliers. Final assembly in Central Europe, close to the Western European market, is currently preferred for the balance of skills, costs and transport infrastructure. Import duty rates for TVs and for the panels also affect this balance. Africa has been suggested as a location potentially competitive in the future. UK import statistics show imports of TV sets in 2007 are mainly from Spain, Slovakia, Hungary, Poland and the Czech Republic - Asia (notably China) is typically only 5-6%. The predominant supply chain model is brand company controlled production of the flat panel module (from Asian made Cells), module manufacture is also moving in some cases from Asia to Central Europe. Brands have more experience of adapting designs to European requirements than smaller Asian panel manufacturers which may seek to establish TV supply to the UK. With flexibility in logistics and internal designs semi-standardised, a company may use a combination of supply chains for different products within the same brand. Manufacturers are sourcing glass and many electrical and electronic components from China and the Far East according to technology specialisms, quality and price, some in kits shipped to Europe for assembly.

Specific data on the range and aggregated quantities of materials within the many sub-components in TVs and their sources is limited, typically to those significant as rare, hazardous or controlled to achieve environmental standards or legislation. Further research would be needed to establish the (potential) effects of Nitrogen Triflouride (GHG) emissions and of depleting rare materials, for example the Indium, Europium and Copper, attributable to TV supply, especially if un-recovered. Further analysis such as Life Cycle Assessments for flat panel TVs, with input from a sufficient range of suppliers, including many in Asia, would be needed to attribute environmental impacts to the supply chain aspects in detail.

1 Introduction

1.1 Introduction

Defra is preparing ten product roadmaps as part of its work on Sustainable Consumption and Production identifying sustainability impacts. Policy options to effect corrective action across product life cycles will be proposed. Televisions are one of the roadmaps in preparation[1].

The TV roadmap will have a firm foundation in the supporting evidence base that has been compiled into the recently published work '*Mapping the Environmental Impacts, Interventions and Evidence Requirements for the TV Roadmap'*[2]. Documents and reports contributing to the evidence base include:

- Ecodesign of Energy Using Products Preparatory Studies (EuP), Lot 5: TVs,
- Market Transformation Programme (MTP) Consumer Electronics Briefing Notes,
- EU Ecolabel for TVs,
- Public domain Life Cycle Assessments (LCAs).

In compiling the evidence from these and other sources, Defra noted a number of important gaps in the knowledge. This study was commissioned to fill in the gaps as far as practically possible. The project was organised into two themes, the objectives of which were to:

Theme 1

- Identify the TV market trends and consumption statistics to establish the consumption volumes in the UK and how it differs from other European countries. This includes expected take up of new technologies. In particular investigate whether and how UK TV consumption stats (technology types, volumes and trends) are different from the EU25 average assessed in LOT5. Statistics to include are:
    - UK market trends, technologies, patterns and value,
    - UK production and consumption volumes per TV type (service and technologies),
    - Public and private consumption expenditure per product type.
- Consider whether there are any impacts related limitations posed by the TV definition and scope LOT5 is using especially regarding UK specific consumption. For example should the scope go beyond the 'TV unit' to include the multifunctional service provided (e.g. digital TV supply etc.) and does this sufficiently effect the environmental impacts given the UK has a big market in this area?
- Specifically focus on the future of TVs as an entertainment media in the home – new services being made available and possible energy implications of those – and identify how functions are likely to change in particular the need for active standby. Provide an overview of likely environmental impacts following the convergence of CE/ICT products.

Theme 2

- Map out the existing global supply chain (cradle to grave) of TVs entering into or being manufactured in the UK.

[1] Defra *Product Roadmaps - Televisions* http://www.defra.gov.uk/environment/consumerprod/products/television.htm

[2] Maxwell, D. (2007). *Mapping the Environmental Impacts, Interventions and Evidence Requirements for the TV Roadmap*, Defra, London. http://www.defra.gov.uk/environment/business/scp/research/pdf/eiitv-report.pdf

- Beyond exports and imports data identify components' origins and types of materials and substances used in the manufacturing process. Implications of the recovery and disposal routes should be highlighted.
- Determine the end of life management of TVs, both domestic and exported bearing in mind the requirements under the WEEE Directive. Although CRT TVs should not be excluded from the scope, the focus of this study should be on recovery options for new technologies (Flat Panel Displays). Existing evidence includes WEEE studies and this could be built into the scope. Focus on the percentage of TVs actually going to reuse, remanufacturing, recycling and known alternatives. Identify volumes where possible (WEEE data reporting due in 2008) and current management routes and direction to discard/dispose of TVs including reuse and second hand market overseas.

The work reported here provides information on each of these aspects including statistics and the views and opinions of members of relevant stakeholder groups.

2 Methodology

2.1 Introduction

The work reported is a summary of an activity using modelling, a literature review and interviews with relevant stakeholders to fill defined gaps in Defra's TV Roadmap evidence base.

For the modelling work three models were compared:

- '*2007 consultation'* model which is the model underlying the analyses presented in the Energy White Paper 2007 consultation paper for consumer electronics[3];
- '*2008 UK TV model*', which is an update of the '2007 sustainable products consultation for TVs' model;
- '*Europe*', the model used in the EuP Lot5 study.

Important information gaps the study addressed included information on TV supply chains and end-of-life management. In this regard, the study team contacted various parties for information and insights including[4]:

- Defra Statistics Division;
- The Environment Agency;
- TV Producers;
- Intellect UK;
- Recyclers Sims Group, EMR Ltd., Wincanton, Shore Recycling, Axion Recycling, and Axr Group;
- Industry Council for Electronic Equipment Recycling (ICER);
- Waste and Resources Action Programme (WRAP);
- Market research companies.

Information was also obtained from organisations known to be active in relevant areas such as Oakdene Hollins regarding their work on product remanufacturing.

Data and information sources are cited in the report.

[3] Energy White Paper 2007 consultation on sustainable products papers http://www.mtprog.com/cms/whitepaper/

[4] A complete list of the individuals and organisations contacted in the course of this work and the issues they were asked to comment upon is provided in Annex A: Study Consultation Contacts and Annex B: Interview Guidelines

3 UK Markets and Consumption

3.1 Introduction

Because TVs are manufactured for a global market, the technology and features for a particular model are very similar. However, the market will vary by way of the popularity of the models purchased. As a result, the overall market may differ in terms of panel technology and screen size. To determine the differences, it is instructive to analyse the TV sales and the proportion of the market for each technology and screen size. This analysis assists in the identification of the technology with highest environmental impact.

Furthermore, there may also be different ownership trends determining how long a TV is used and how many TVs are owned. This is measured against demographic data, i.e. TVs per household and per person. Finally, the usage could also differ and it is useful to describe this against TV stock and also demographics. The combination of these give an indication of the intensity of UK TV-use compared to similar information used to inform the EuP Lot 5 TV study and whether this alters the balance of the impact of the life-cycle environmental aspects.

In the following discussion, three datasets are compared:

Europe

- The **EuP Lot 5 TV** study completed in 2007, which covers all market and environmental aspects of TVs in the EU25 to 2010. This is variously referred to as 'Europe', 'EuP' and 'EU25'.

UK

- The **2007 sustainable products consultation for TVs**. This model was developed to inform the UK consumer electronics consultation which alongside 11 other separate papers implemented an Energy White Paper commitment to publish a series of papers analysing how the performance of a range of energy-using products will need to improve over the next 10 – 20 years. Full model assumptions can be found in the MTP Briefing Note, BNTV01[5]. This is referred to as the '*2007 consultation*' model.
- The **2008 UK TV model**. For the purpose of this report the 2007 stock model developed by the Market Transformation Programme to inform the consultation on sustainable products was kept as baseline but some of its elements were updated thanks to additional evidence gathered as part of the roadmap process[6]. However, this 2008 TVs model constitutes an interim solution and a snapshot in time specifically brought forward to inform Defra's roadmap, and will likely be subject to further changes in the coming months at the time of finalisation of the next round of public consultations. This is referred to as the '*2008 TV* model'.

3.2 Technology

There are five types of TV technology:

- Cathode Ray Tubes (CRT). This is the traditional TV technology characterised by a deep cabinet and low resolution.

[5] BNTV01 Changes and Trends in Television Technologies (2007) - http://www.mtprog.com/cms/product-strategies/subsector/consumer-electronics

[6] GfK *Retail Audit Panel Consumer Electronics Hitlists*; Mintel report – *Televisions, Market Intelligence, November 2007*; Energy Saving Trust *Act on CO_2* data, 2008

- Liquid Crystal Display (LCD) which use the same technology as modern flat screen computer monitors. There are many variations of LCD technology which offer different performance characteristics and costs.
- Plasma is typically found in large screens.
- Rear Projection which projects a image onto a screen.

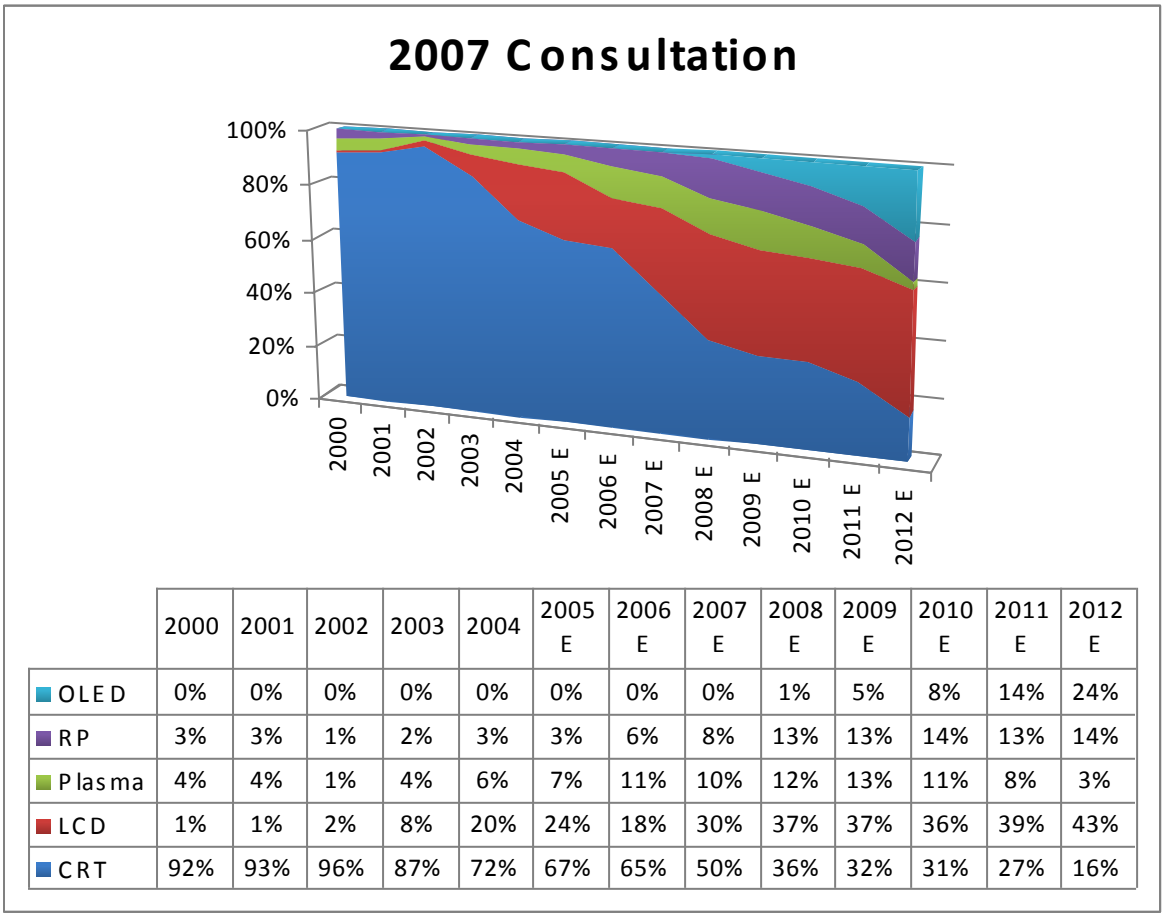
The historic UK technology split is determined primarily from GfK Retail Audit Panel Consumer Electronics Hitlists and projected using expert judgement and industry statements.

Figure 1shows the TV market sales by technology for Europe and UK. The 'E' on the X-axis indicates the years for which sales are estimated and the '*' (in the diagram for 2008 TV model) where there is high confidence in the data used. This shows that LCD is the dominant technology to 2012. However, newer evidence suggests that the UK TV market is substantially changed from the 2007 consultation projections. In particular, the share of LCDs in 2006 is 49% in 2008 model projection, clearly higher than the 42% projected in Europe and 18% in the 2007 consultation which coincides with a much faster decline in CRT sales. Rear projection and OLED sales have also been lower.

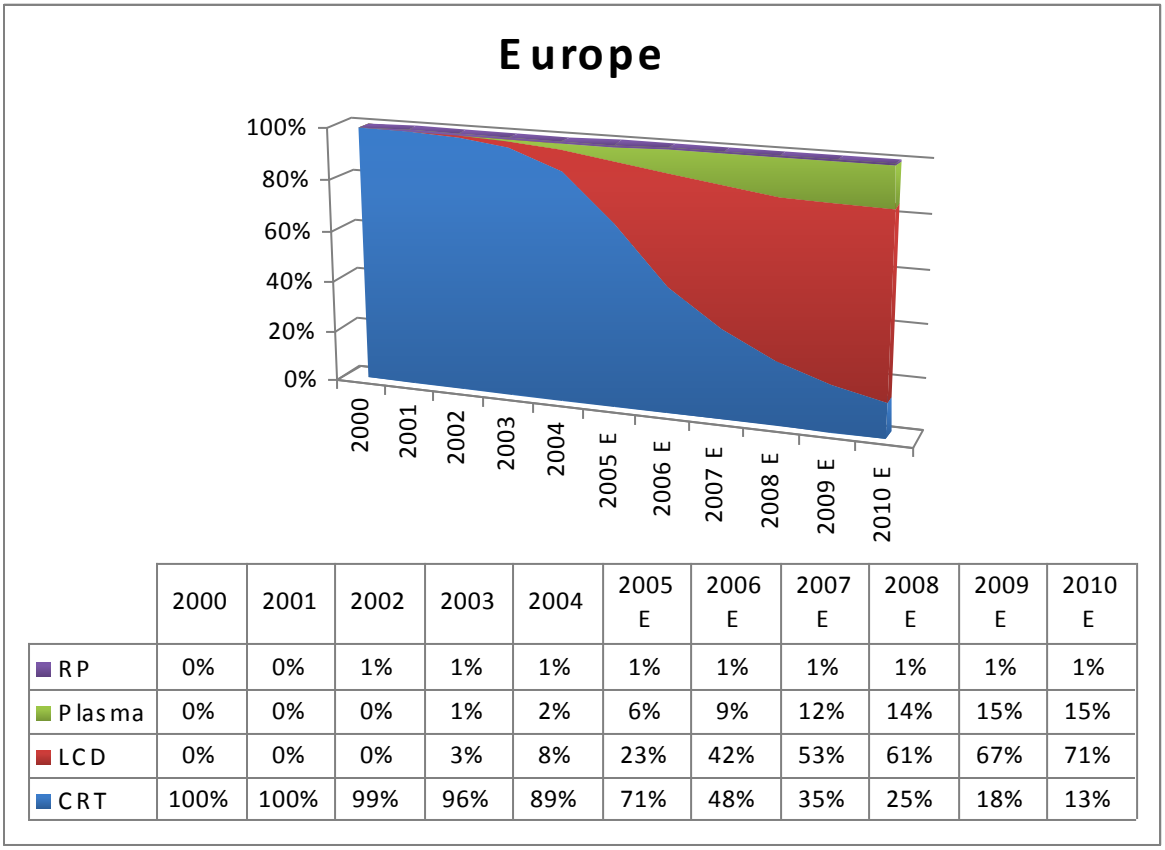
Evidence supporting the 2008 UK TV model of the very high popularity of LCDs can be seen in supply chain and retail channels. Rear projection TVs are no longer available from many major big-box retailers whilst Plasma TVs are no longer manufactured by Sony[7], Fujitsu, or Pioneer. Simultaneously, many brands are now marketing increasingly large LCD panels (42+") to occupy the 'traditional' Plasma market.

[7] Digitimes (2007) http://www.digitimes.com/displays/a20060803A6030.html [online. Accessed 12-5-2008]

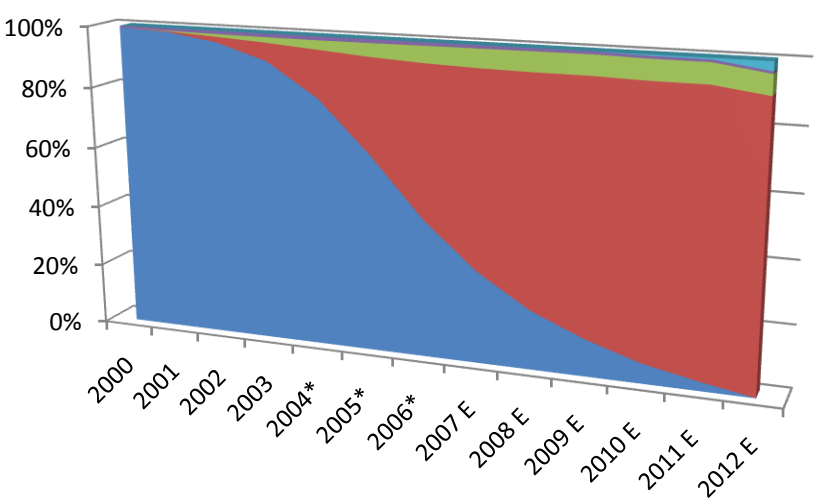
Figure 1 - TV market by technology



	2000	2001	2002	2003	2004	2005 E	2006 E	2007 E	2008 E	2009 E	2010 E	2011 E	2012 E
OLED	0%	0%	0%	0%	0%	0%	0%	0%	1%	5%	8%	14%	24%
RP	3%	3%	1%	2%	3%	3%	6%	8%	13%	13%	14%	13%	14%
Plasma	4%	4%	1%	4%	6%	7%	11%	10%	12%	13%	11%	8%	3%
LCD	1%	1%	2%	8%	20%	24%	18%	30%	37%	37%	36%	39%	43%
CRT	92%	93%	96%	87%	72%	67%	65%	50%	36%	32%	31%	27%	16%



	2000	2001	2002	2003	2004	2005 E	2006 E	2007 E	2008 E	2009 E	2010 E
RP	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Plasma	0%	0%	0%	1%	2%	6%	9%	12%	14%	15%	15%
LCD	0%	0%	0%	3%	8%	23%	42%	53%	61%	67%	71%
CRT	100%	100%	99%	96%	89%	71%	48%	35%	25%	18%	13%



	2000	2001	2002	2003	2004 *	2005 *	2006 *	2007 E	2008 E	2009 E	2010 E	2011 E	2012 E
OLED	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
RP	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Plasma	0%	0%	1%	2%	3%	4%	5%	6%	6%	6%	6%	6%	6%
LCD	0%	0%	2%	6%	15%	31%	49%	63%	74%	81%	86%	89%	90%
CRT	99%	99%	96%	91%	81%	64%	45%	30%	19%	12%	7%	3%	0%

Dominance of LCD technology is expected in UK and Europe because it can be scaled to small and large screens (small screens are not yet commercially viable for plasma displays) while offering a number of advantages to the consumer over CRT. The most important of these are the much smaller size compared to CRT and higher quality pictures displayed by high definition panels. Whilst LCD image quality was considered poorer than plasma, the difference is no longer a factor for most consumers. Even at small screen sizes, LCDs are expected to dominate in the UK as the price falls below the threshold where it is a factor influencing a consumer purchasing decision, whereas in Europe this consumer threshold price is thought to be lower.

Looking ahead even further, present research and development work to develop 3D TV may see resurgence in interest in plasma screen technology as LCD is not suitable[8].

As a result policies that are able to accelerate the development of more efficient LCDs, e.g. by increasing the amount of light transmitted through the screen and using high efficiency LED backlights when available may have a large impact.

3.3 Screen Size

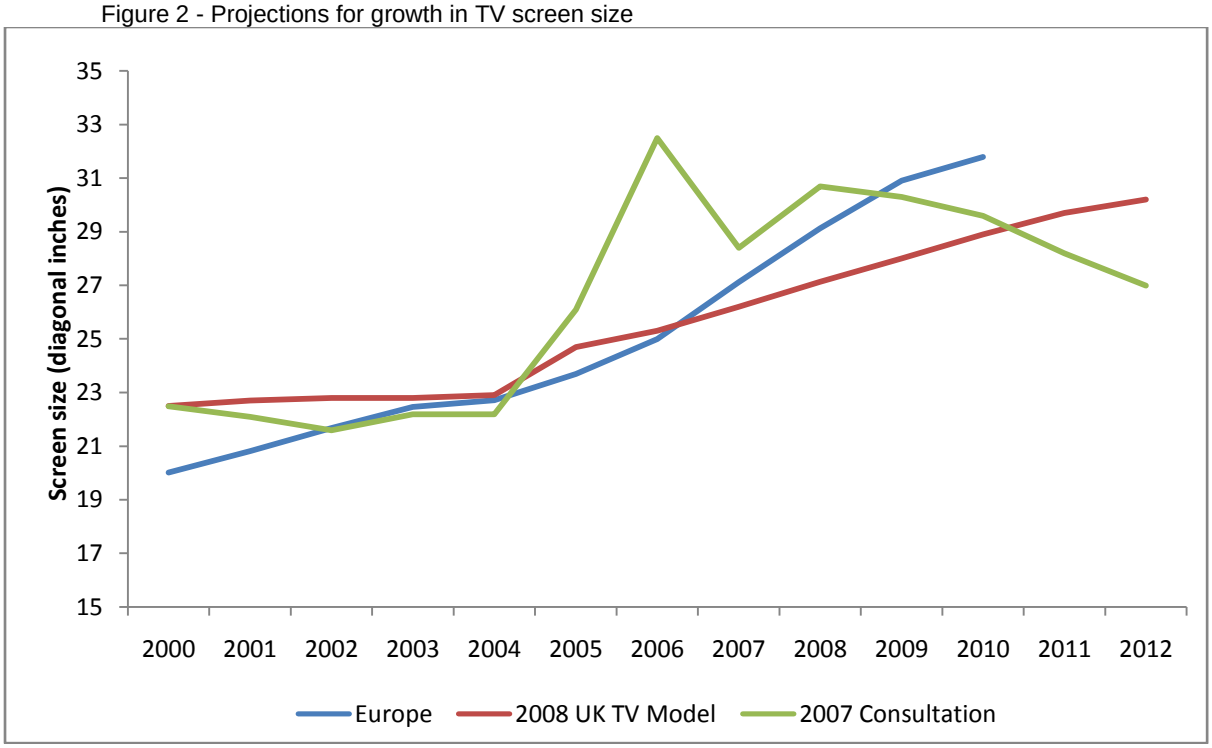
Screen size is expected to rise in the projections made using all three models, however, differences in the published data structure mean that direct comparison is not possible. As a result, it may not be possible to draw valid conclusions from their analysis.

[8] Private communication, UK Intellect

The EuP Preparatory Study "Televisions" (Lot 5) data splits the screen size into three broad groups 14"-26", 27"-39", 40"-70". However, it is not possible to determine the exact mean screen size within each group, which creates an error of up to ±30%. In particular, it is unlikely that the mean screen size in the 40"-70" is the median value of 55". Therefore, to convert the data to a similar format as MTP, the MTP's median sizes were chosen – 17", 32" and 42".

The graph in Figure 2 below shows screen size in Europe is increasing most rapidly. The 2007 consultation data shows large variation in screen size which is an artifact of the model. The 2007 consultation model is based on power demand and has no screen size information. The graph shows the retrospective calculation using predicted efficiency levels. The 2008 UK TV model data shows the UK screen size is historically larger, but the rate of increase is slower, than Europe and is overtaken by 2007. This may be a result of the high proportion of secondary TVs in the UK market which, due to available data, are assumed to be smaller than 26".

Figure 2 - Projections for growth in TV screen size



In summary, the graph suggests the average screen size could be larger, or smaller than Europe, but any conclusions are unlikely to be statistically significant as a result of the modelling differences discussed earlier. Therefore it is not possible to conclude if the environmental impact arising per TV is larger in the UK than Europe.

Screen size is important because, for a given technology, a larger TV will require more materials to manufacture and create more waste, as well as consuming more energy in production and in use. There is strong independent testing data to show that screen area and power demand increase linearly. However, only a small set of manufacturer data was available to check the screen area-weight relationship. This suggests it is also linear and therefore screen size does not affect the balance of the environmental aspects.

3.4 Stock, ownership and usage

TV stock is generally expressed in terms of TVs per household, but it is more instructive to analyse this against population since there are differences in demographics and household make-up of the UK

and EU-25. The EuP Preparatory Study "Televisions" (Lot 5) report includes the most data on stock for 2003 and 2010 and so these years are compared.

Table 1 - Population (millions) Source: Eurostat[9].

	2003	2010
EU25	460.0	464.0
UK	59.4	60.9

It should be noted that the population includes people of all ages and circumstances, and the comparisons are for statistical purposes.

The stock data shows that there are substantially more TVs per person in UK than Europe. Furthermore, the 2007 consultation model suggests that there are more TVs in use than people in the UK. This is based on a 2000 survey, which may have not accurately reflected UK demographics. The 2008 stock is modelled using Broadcasters' Audience Research Board (BARB) data series of the number of TVs per household.

Table 2 - TV stock per person

	2003	*2010*
EU25	0.59	0.84
2007 Consultation	1.07	1.09
2008 UK TV model	0.87	0.98
relative difference		
EU25	100%	100%
2007 Consultation	180%	130%
2008 UK TV model	147%	116%

Sales are also higher per person than in Europe, which can be seen by the faster replacement rates and shorter lifetimes. The average TV is expected to last 10 years in Europe, compared to 5.2 to 7 years in the UK. Another way to show this is the number of years between TV purchases. It should be noted that a TV purchase is expected for *every* person, not just the smaller economically active demographic. Using this demographic would reduce the number of years between purchases.

Table 3 - Time in years between TV purchases per person

	2003	*2010*
EU25	14.90	12.70
2007 Consultation	6.70	5.24
2008 UK TV model	9.99	8.64
relative difference		
EU25	100%	100%
2007 Consultation	222%	242%
2008 UK TV model	149%	147%

[9] Eurostat (2007) *Total Population:. At 1 January (1997 – 2008)* http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_population&root=Yearlies_new_population/C/C1/C11/caa10000 [online. accessed 4-6-2008]

Higher sales rates indicate greater production and waste impacts of TVs.

The usage pattern (hours a TV spends in the on-mode per day) assumed in the EuP study is very simple at 4 hours per TV. This falls to 3 hours as the number of TVs per household increases. This trend towards many and bigger TVs watched for fewer hours will increase the relative impact of production and disposal phases of the life cycle.

In the UK, 2007 consultation usage is assumed at 6.5 hours for the primary TV and 2.5 for each additional TV in a household. This gives an average of slightly over 4 hours with the assumed value increasing to 2010. In the 2008 UK TV model, there is also an increase in TV usage despite the increased number of TVs per household. The increase in usage is approximately the same as the increase in stock and therefore, the impact of production and in use is unchanged.

Table 4 - TV usage (hours on /day)

	2003	*2010*
EU25	4.00	3.00
2007 Consultation	4.22	4.63
2008 UK TV mode l	3.42	3.71
relative difference		
EU25	100%	100%
2007 Consultation	106%	154%
2008 UK TV model	85%	124%

3.5 Summary

There is a higher intensity of televisions in the UK both in stock and usage terms. However, there seems to be little difference between the TV models entering the market with screen size projected to be similar and LCD technology dominant. Therefore, the technical analysis in the EuP will be valid in the UK scenario.

The main difference exists in the higher stock, faster turnover of stock and higher usage of TVs in the UK. This means that TVs create a larger environmental impact per person and therefore may be considered a higher priority. Furthermore, to limit the environmental impact per person, or to reduce it to similar levels as Europe, the TVs in the UK market would need to be more energy efficient and have lower material impacts than the European market as a whole. The practicalities of achieving this are dubious, however, as TVs are generally produced for a global market rather than a country specific one.

A very simple total TV impact "score" was produced to illustrate the differences in the cumulative impact by multiplying the relative impacts of TV stock, TV sales and TV usage per person. These were not weighted to take into account the magnitude of the respective impacts. Since all these factors are higher in the UK, there is a very large overall increase in impact. Using the 2007 sustainable products consultation, this suggests that UK impacts of TVs per person could be as much as 4 times greater than Europe and could be set to increase to almost 5 times. However, with the updated data in the 2008 UK TV model snapshot, the impact is approximately twice the EuP prediction.

Table 5 - Total TV impact /person relative to EuP study

	2003	*2010*
EU25	100%	100%
2007 Consultation	422%	486%
2008 UK TV model	187%	211%

3.6 Public and Private Sector Consumption of TVs

Based on 2007 market data[10] private sector consumers have now effected a near total switch to the newer flat panel display TV types of LCD and plasma. Whilst in 2005, 50% of TVs purchased by households were CRT, by late 2007 CRT's market share had dropped to less than 10%.

The value of the consumer TV market continues to grow with sales in 2007 of all TV types being valued at £2.5 billion (Mintel). Whilst we do not have access to data disaggregating sales into technology type, it is possible to form a crude estimate as follows based on unit sales by technology type:

- CRT TV market share is 10%, and the estimated sales value of a CRT is a third that of a LCD or PDP,
- LCD TV market share is 75%, and the estimated sales value of a LCD TV is equivalent to that of a PDP
- PDP TV market share is 15%, and the estimated sales value of a PDD TV is equivalent to that of a LCD

From which the market value attained by the different technologies can be estimated:

- CRT TV – £0.08 billion,
- LCD TV - £2.01 billion,
- PDP TV – £0.40 billion.

Data describing the market situation for public purchasers is sparse. The *UK Government Sustainable Procurement Action Plan, 2007* identifies the amounts of money spent on particular product areas. Televisions are included in the product category '*Telecomms, TV and Radio'* that also includes Mobile Phones, VCRs, DVDs, Terrestrial Digital Adapters and Faxes. The analysis suggests that the estimated spend for the product category as a whole is £4.21 billion. The contribution TVs make to the whole is not known[11].

Further discussion with Defra identified an alternative product sector categorisation of public procurement for '*Radios, Televisions and Telecomms'* for which spend in 2003 was £0.8 billion[12]. Again it is not possible to drill further down to extract a TV figure although, we believe the total is influenced strongly by the category 'Telecommunications' rather than TVs. That being the case, in the absence of any other evidence we suggest an estimate of 10% of the total is attributable to TVs suggesting the public purchase of the product type is valued at around £80 million.

We have sought to corroborate the estimate via an alternative mechanism using the National Statistics publication '*UK Business: Activity, Size and Location – September 2007'*. The statistics identify the number of facilities falling into discrete categories of activity. Three categories are relevant to the public sector – Education, Health and Public Administration and Other Services. For England and Wales, 240,950 facilities fall into these three categories. If we assume that each facility has three TVs and that 10% are replaced each year then the number of TVs bought by the public sector is 72,000.

[10] Mintel report – *Televisions, Market Intelligence*, November 2007

[11] Private communication, Defra May 2008

[12] Private communications, Defra, June 2008

At a typical cost of £500 per TV, the value of TVs purchased is estimated at £36 million which, given the sketchiness of the data, compares reasonably with the £80 million estimate above.

Whilst these figures are little more than estimates, they do suggest that the private sector purchase of TVs is significantly higher than that for the public sector.

4 UK Situation Compared to EuP Lot 5

4.1 Introduction

The complementary evidence paper, '*Mapping the Environmental Impacts, Interventions and Evidence Requirements for the TV Roadmap'*[13] summarises the key environmental impacts identified through different sources, including the EuP Preparatory Study "Televisions" (Lot 5), however, the constraints of the TV system definition used for the EuP study limit the evaluation of the impacts. Clearly, if the definition of the system under investigation were the 'TV system', including other devices linked to the use of a TV, the environmental impacts would be greater. The question is, how much greater in the UK?

The product scope of EuP Lot 5 'Televisions' (for which definitions are provided below) is:

- Televisions (TVs)
- TV/Video combination unit
- TV component unit

The following products/applications are excluded from Lot 5:

- TV peripherals
- TV capable peripherals

The study adopted a product group definition with limited scope on the basis that:

- TV peripherals use different materials in different quantities to a stand-alone TV and have different functionality,
- TV capable products provide other functions in addition to displaying TV signals. Because their TV functionality is ordinarily of secondary importance, they are better considered under a different product category such as computers.

Product Definitions

Television: A commercially available product that is specifically designed to receive and decode a television transmission (broadcast from cable, terrestrial or satellite), whether analogue or digital (integrated tuner), and displays the resulting image on an integrated screen while reproducing the accompanying sound (main function). The tuner/receiver and monitor are encased in a single housing. The product should be mains powered.

TV/Video Combination Unit: A commercially available product in which the TV and a Video Recording/Storage/Replay System (e.g. videocassette, standard or high definition DVD, hard disk dive, memory chips, or combinations of them) are combined into a single housing. The product should be mains powered.

TV Component Unit: A commercially available system, which is marketed and sold as a TV, consisting of a receiver and monitor in separate casing. Video is a further optional unit or could be integrated in one of the other units. The system should be mains powered and may have more than one power cord.

TV Peripherals: A commercially available stand alone device such as a Set-Top-Box (STB), Videocassette Recorder/Player, and DVD Recorder/Player, which is mains powered.

TV Capable: A commercially available TV receiver component such as a PC or Laptop accessory (e.g. TV tuner card), receiver integrated in mobiles (e.g. TV capable Mobile Phone), as well as Beamer/Video Projectors that are not specifically designed TVs but capable of displaying a TV/video signal from an STB or PC.

[13] Maxwell, D. (2007). *Mapping the Environmental Impacts, Interventions and Evidence Requirements for the TV Roadmap,* Defra, London. http://www.defra.gov.uk/environment/business/scp/research/pdf/eiitv-report.pdf

4.2 Are the Exclusions of EuP Significant for the UK Situation?

EuP Lot 5 'Televisions' adopted a limited product definition for its work which, given the work's remit, was desirable. In the UK though, the sales and stock of some of the products excluded from the Lot 5 study are significant. Therefore, for the Defra TV Roadmap, it is appropriate to consider to what extent a more expansive product definition would affect the scale of the environmental impacts.

Table 6 below summarises data generated using the '2007 sustainable products consultation for TVs' model'. (Selection of this model for the comparison, rather than the updated '2008 UK TV model' is due to the latter model's exclusion of updated information on all consumer electronics devices under consideration.) The data provided is that attributable to a product's total use and in this respect will include energy consumed for uses other than watching television (for example, gaming). This model does not disaggregate, for say, a personal computer how much of its use is for computing, on line shopping or television.

Table 6 - Comparison of energy consumption for TVs and related products

UK Market	All figures are earliest best practice figures			
Product	Category	Projected usage 2008	Projected usage 2012	% change
TVs (EuP Definition)	Energy consumption (GWh)	6,046	6,454	7%
	Stock figures	61,861,251	55,350,213	-11%
	Sales figures	6,845,200	7,228,055	6%
STB	Energy consumption (GWh)	3,456	4,268	23%
	Stock figures	15,787,007	30,707,552	95%
	Sales figures	6,115,404	8,655,152	42%
PC Monitor	Energy consumption (GWh)	4,233	1,888	-55%
	Stock figures	15,487,167	8,473,089	-45%
	Sales figures	2,144,981	1,242,927	-42%
Video Beamer (Projector)	Energy consumption (GWh)	989	1,904	93%
	Stock figures	3,213,515	7,517,058	134%
	Sales figures	1,248,621	1,464,090	17%
VCR/DVD stand alone	Energy consumption (GWh)	1,891	1,001	-47%
	Stock figures	45,270,168	45,753,539	1%
	Sales figures	6,207,128	6,016,210	-3%
Mobile	Energy consumption (GWh)	248	84	-66%
	Stock figures	70,000,000	70,000,000	0%
	Sales figures			
Laptop	Energy consumption (GWh)	739	1,041	41%
	Stock figures	14,582,945	27,092,559	86%
	Sales figures	5,522,894	8,749,614	58%
Total	Energy consumption (GWh)	16,613	14,737	-11%
TVs (EuP Definition)		6,046	6,454	7%
TV Peripherals and TV Capable		10,567	8,282	-22%
TV Peripherals and TV Capable as % of total consumption		64%	56%	

EU Market 2003/2005				
Product	Category	Usage 2003/2005	Projected usage 2010	% change
TVs (EuP Definition)	Energy consumption, 2005 (GWh)	55,000	90,857	65%
	Stock figures, 2003	271,195,001	391,513,000	44%

As the above table shows, to ignore the contributions of TV peripherals and TV Capable components will omit 64% of the UK product sector's energy consumption in 2008 and a projected 56% energy consumption in 2012. These figures are not insignificant, and to ignore the contributions of TV peripherals and TV Capable components would give an inaccurate picture of the UK TV market's figures on energy consumption and emissions, and can be expected to have similar bearing on other

impacts such as waste generation and materials consumption etc. Therefore, it would be worth considering the inclusion of TV peripherals and TV Capable components when assessing the environmental impact of the UK market. A significant lack of existing data on the energy consumption of sound systems connected to TVs meant that audio equipments were not listed in the comparison table, however the overall energy used by those appliances are deemed to be fairly significant for some users and would benefit from being included in the scope.

Although the data available from EuP Lot 5 is not for the same period, 2008 – 2012, it does give an indication of the differences between the European average market and the UK market.

In summary, the product exclusions under EuP are significant to the point that EuP does not accurately portray the UK market when considering the 'TV system' which includes other devices linked to the use of a TV.

4.3 Comparison of UK and EU Information

It should be recognised that the MTP indicative performance targets are based on the best practice of models in the current market place and are unlikely to reflect the full energy efficiency potential of products by 2015. The UK government is committed (in the 2007 Energy White Paper) to review the indicative performance targets annually, and this mechanism will allow the UK to adjust targets to reflect technological change.

A further observation to note is that the suggested 101W maximum energy consumption specification for televisions of 23in. or below proposed by the EuP preparatory study would do little to push environmental performance in this size bracket. The assertion of the study that the market segment below 23in. is minor is not supported by UK evidence. MTP evidence suggests that 51% of the televisions sold in 2006 were under 24in[14], and that the energy consumed by TVs of this size (<24in.) represented as much as 21% of the total energy consumption of televisions[15]. In fact MTP evidence[16] suggests that none of the televisions below 23in consume more than 100W meaning that all TVs in this size category would meet the minimum standard.

[14] Source: GfK Retail Audit Panel *Consumer Electronics Hitlists* data for 2006.

[15] Source: *2007 consultation* model

[16] The current MTP evidence base is a sample of 115 televisions tested under the proposed revision to the IEC62087 methodology. None of the televisions in the sample are under 23in. screen size. This statement is based an older data set of 634 televisions, tested under the current test methodology, and which contains a significant number of televisions under 23in.

5 Product Convergence

5.1 Introduction

Product convergence with TVs refers to two areas, consumer electronics and ICT. Convergence is only likely to take place where the services offered by separate products are complementary. For example, integrating terrestrial digital tuners is a certainty due to the digital switchover. In addition, the types of products likely to converge may also depend on the rate of change in technology and its related lifetime.

As a result of convergence there may be a difference in the usage patterns and the power demand when compared to the separate products which will affect its in-use energy consumption. It is also expected that the material impacts will change.

This section presents a number of probable convergence scenarios based on the TV becoming the dominant product and analyses the energy and environmental implications of this compared to standard scenarios.

5.2 Probable Scenarios

5.2.1 Assessing individual product convergence

The first criterion to determine is which products are likely to converge and in doing so it is assumed that the services must be complementary. For TVs, this means the product will only converge if it requires a screen to display a picture. Therefore, audio equipment, monitors, communication devices (network routers, phones) and printers are not considered.

Using MTP product definitions, this leaves video recorders/players, computers and set top boxes. Table 2 summarises the services and the likelihood of convergence of these product areas based upon lifetime, technology and service. Digital terrestrial receivers are not considered because convergence has occurred driven by the digital switchover.

It can be seen that product lifetimes are all similar and therefore this will not force early obsolescence or failure of the larger converged product, instead of the smaller, separate products. The possible exception to this is computers, which tend to become obsolete as a result of newer software requiring more powerful computer processors. However, the convergence of PCs is limited to a service subset including internet and streaming video and it is unlikely that the user will be able to install their own software. This is due to a number of factors including usability, cost of integrating powerful computer hardware and lack of demand for the additional functionality.

DVD players and Blu-ray are not considered but for different reasons. The market for DVD players is now saturated and it is therefore unlikely that there is market demand for both a new TV and DVD player at the same time. Where this does occur, DVD players are already available at very low cost. It should be noted that converged products are currently on the market but they are generally limited to small screens (around 19") and often cost the same as buying the separate units. Blu-ray, however, is still very new and expensive. At this stage it is not possible to predict the market penetration or power consumption of blu-ray players to 2012. Furthermore, the attraction of the new generation of video player is very high quality image and sound. Therefore, the current target market is the home theatre, which will include a large screen and separate surround sound hardware. Convergence is

undesirable in this situation since it limits choice and the ability to individually replace components of the home theatre system.

Another factor limiting the scope of convergence is the proprietary and closed eco-systems of some equipment. The best example of this is satellite and cable set top boxes where the service provider uses encryption to distribute content and also maintains close control of the hardware and user experience. In addition, the consumer must be connected to the service by installing a satellite or cable equipment. Whilst there is no technical reason why this could not converge, the market and business model means this is thought to be unlikely in the relatively short term (2012).

Table 7 - Summary of possible CE/ICT products for convergence

Product	**Lifetime (years)**	**Power (W)**	**Technology change**	**Service**	**Convergence possibility**
TV	4.9-6	*On:* 105-125 *Standby:* 2.6-2.5	LCD and Plasma screen technology (image quality) is still maturing	Audio/visual output and viewing of free over the air transmission	
Video recorders: DVD Blu-ray HDD DTR	6-7	*On:* 13-30 *Standby:* 3-6 (excludes blu-ray)	DVD is very mature. Blu-ray is very new and rapidly changing. HDD recorders relatively stable.	Transportable, time independent viewing of TV/movies etc. Higher quality A/V.	HDD is likely. Ownership of DVD players is high and are very cheap (£20). Blu-ray is currently too new and expensive
Computers (laptops and desktops inc monitor)	4-4.4	*On:* 95-81 *Standby:* 3.4-1.8	Increasing diversity of products but underlying system is mature	Entertainment: *Internet, streaming video, games, other multimedia* Work and office application	Basic internet access and multimedia likely. PCs will still be required for work
Set top boxes (exc freeview)	5-6.7		Development cycles tend to be 5 years between major platform upgrade	More premium TV content, eg sports, movies and video on demand	Market structure makes this unlikely

5.2.2 Likely products

Two areas of convergence are considered likely: hard disc digital terrestrial recorders (DTRs); and basic computer functionality. Such products have been announced recently including integrated hard discs[17] and IPTV enabled[18]. An important point to note is these are large, flagship models which suggests that converged TVs will expand beyond the lower cost, space conscious products.

5.3 Usage

Usage patterns are estimated from the MTP usage of the individual products. These are then weighted by the sales of the products relative to TVs to take into account the different household ownership levels. For PCs the on-idle usage time was broken down into three states – entertainment, work and

[17] LG (2007) Model : 42LT75 <http://uk.lge.com/products/model/detail/lcdtv_42lt75.jhtml> [online. accessed 4-6-2008]

[18] Panasonic Press Release *Panasonic announces availability of its first VIERA CAST web-enabled plasma HDTV* ,20 May 2008. ftp://ftp.panasonic.com/pub/Panasonic/pressroom/pdfs/panasonic_viera_pz850_pressrelease.pdf [online. accessed 4-6-2008]

unattended (either left on or downloading). The breakdown was based on expert judgement and is subject to variability. To account for this two usage scenarios are applied to the converged TV+PC product; one including the unattended time and one excluding it. Table 8 details the assumed daily usage time for each state. From this, three usage scenarios are created for the converged products TV+DTR, TV+PC Ent and TV+PC Ent+Unattended. In addition there are two unconverged, baseline scenarios for comparison in Section 5.4.1 Maximum Power.

Table 8 - Daily usage time in each state

Year	TV on (hr)	DTR record (hr)	PC Ent (hr)	Unattended (hr)
2008	4.44	0.43	2.55	3.52
2009	4.54	0.58	2.64	3.67
2010	4.63	0.65	2.53	3.56
2011	4.69	0.40	2.41	3.42
2012	4.69	0.49	2.67	3.81

5.4 Power demand

The power consumed by a converged product compared to the sum total power consumption of separate devices may fall slightly because of more efficient use of circuitry, such as the sharing of digital tuner circuitry for the TV and recorder. However, there is no evidence determining the magnitude of the potential saving.

Although the total power demand may be lower, in normal usage not all services will be accessed and required simultaneously. Therefore two scenarios occur:

- power consumption may rise if the TV activates all extra functions regardless of which are being used,
- power consumption falls provided equipment has internal power management which can assess which functions are needed and only provide power when required[19].

Different power levels were estimated by breaking down the power consumption for each service or function of the device. These are detailed in Table 9. The additional PC base load uses the MTP figures for laptops as a proxy for a low power computing device and the DTR base load is based on the MTP DTR after subtracting the terrestrial STB power to give only the marginal increase of the recording circuitry.

Table 9 - Power consumption breakdown

Year	TV screen (W)	TV baseload (W)	Additional PC baseload (W)	Additional DTR baseload (W)
2008	83	23	18	21
2009	90	23	18	21
2010	95	23	18	21
2011	100	23	18	21
2012	101	23	18	21

5.4.1 Maximum power

Table 10 shows the maximum power of the individual and converged products. It can be seen that the TV+DTR has a lower power than the sum of the TV only and DTR only which is due to the

[19] Australian Digital Testing, *Discussion Paper: SetTop Boxes – Issues with Complexity*, 2008 (Report Number: ADT07E - unpublished draft).

calculation methodology. The TV+PC converged product, however, has a higher power (124 W in 2008) than the PC only (95W which includes the monitor). Although the PC component of the converged product is low the TV screen is significantly larger and brighter than a computer screen, which outweighs the computer components power consumption. The difference also diverges as the TV power continues to increase (142W in 2012) but the PC uses less (81 W).

Table 10 - Maximum power of individual and converged products

Year	TV only (W)	TV+DTR (W)	TV+PC (W)	PC only (W)	DTR only (W)
2008	106	127	124	95	28
2009	112	134	130	90	28
2010	118	139	136	86	28
2011	123	144	141	81	28
2012	124	145	142	81	28

5.4.2 All power levels

If power management exists other power levels must be defined. These are determined by summing only the necessary functions.

Table 11 - All power levels

Year	PC unattended (W)	DTR recording (W)	Watching TV (W)	PC Ent (W)	TV with live pause/ DTR playing (W)
2008	18	44	106	124	127
2009	18	44	112	130	134
2010	18	44	118	136	139
2011	18	44	123	141	144
2012	18	44	124	142	145

5.5 Energy consumption

The energy consumed by the converged products are shown in Table 12. The results are not straightforward and the changes very dependent on particular scenarios and uses.

Under low usage, with or without power management, the energy consumption of the TV+PC is higher than the unconverged TV and PC (Table 12a). This is primarily because the power demand of the TV is significantly higher than for a monitor. Power management is important however, to minimise the increase.

If the converged product is unattended and has power management that switches off the screen, the overall energy is lowered (Table 12b). This is because significant time is spent in the unattended mode where the less powerful converged PC components (18W) consume less energy than a normal PC. Without power management, the energy consumed is significantly higher.

Table 12c shows that a converged TV+DTR uses less energy. This is simply because under the current usage scenarios, it is assumed most DTRs are not switched off with the TV and therefore remain on all the time. Convergence solves this behavioural issue, greatly reducing energy consumption. A similar effect can be achieved by other forms of power management such as Intelliplug™ or auto-standby in DTRs.

Table 12 - Energy consumed for the products and scenarios

12a. TV+PC low usage scenario

Year	Unconverged (kWh)	Converged inc power management (kWh)	% change	Converged exc power management (kWh)	% change
2008	712	787	110%	867	122%
2009	746	852	114%	933	125%
2010	763	890	117%	974	128%
2011	773	917	119%	1001	130%
2012	798	961	120%	1045	131%

12b. TV+PC high usage scenario

Year	Unconverged (kWh)	Converged inc power management (kWh)	% change	Converged exc power management (kWh)	% change
2008	1046	850	81%	1303	125%
2009	1075	918	85%	1411	131%
2010	1069	955	89%	1458	136%
2011	1051	978	93%	1483	141%
2012	1106	1029	93%	1586	143%

12c. TV+DTR

Year	Unconverged (kWh)	Converged (kWh)	% change
2008	705	583	83%
2009	798	634	79%
2010	857	672	78%
2011	805	693	86%
2012	842	702	83%

5.6 Material effect

Convergence of two products will clearly reduce the materials used compared to two separate products, the most significant being the housing and power supply. However, if the additional service was not likely to be used, then material impact will rise.

PCs are not expected to be replaced by a converged TV, so there is likely to be a small increase in material impacts from the additional electronic components in the TV. Replacement is not expected to occur because the PC in a traditional work configuration is still required.

5.7 Conclusions

Three possible convergence scenarios were modelled to provide a realistic projection of the effects of convergence. However, the market is changing very rapidly and it is very difficult to predict what might happen. For example, it was assumed that broadcast platforms such as satellite and cable will not converge to allow greater control of services. But while writing this report, Sony announced that they have agreed a common platform in the US with cable service providers that still provides the ability to create unique products[20].

[20] NCTA (2008) *Sony Electronics and Major U.S. Cable Operators Negotiate National "Two-Way" Plug and Play Solution*. http://www.ncta.com/ReleaseType/MediaRelease/Sony-and-Cable-Operators-Negotiate-National-Two-Way-Plug-and-Play-Solution.aspx [online. accessed 6-6-2008]

The energy consumed by converged products compared to the individual products changes on a case by case basis; the modelling suggests this varies between a 20% reduction to a 40% increase in the worst case. However, the result is not unique to convergence itself i.e. it is determined heavily by the assumed screen size of TVs versus monitors and usage patterns for DTRs. These effects can be replicated with alternative markets scenarios and technologies.

Convergence is likely to increase energy consumption if the products are not equipped with adequate power management features. With power management, savings can be realised simply because it reduces the number of products left on unnecessarily. Power management in converged products should also be required to prevent the increase in energy consumption by switching off internal services if, in future, they are being provided by external devices.

On a practical level though, whether convergence will be realised is a moot point. Producers say the market does not want converged products and point to the less than successful TV/computer and TV/mobile phone combinations. They also indicate the environmental disadvantages in pursuing the concept. For example, with digital television, the better solution is a separate TV and set-top box with the reason being that an enhanced digital service is already being considered. Existing digital tuners will not be able to decode the signals. Hence producers say it is better to replace a small box than an entire TV[21].

[21] Intellect *Consumer Electronics Conference 2008: Tomorrow's Technology*, 3 July 2008.

6 Supply Chain

6.1 Background

The TV supply chain is changing rapidly through both the change in technology from CRTs to flat panel display TVs and the business models of the panel and module manufacturers. Current trends may begin to supersede the general developments in the TV supply chain characterised by:

- **Modularity and standardisation** in global product designs and manufacturing, accelerated by the transition from CRT to flat panel display (FPD) TVs. A trend termed 'virtual integration'[22] companies dynamically replicate assembly to suit global location factors (skills, costs, logistics) and co-ordinate external suppliers, contrasts the historical vertical integration in industrialized regions. It is cheaper to ship millions of small parts bought at competitive prices to regional assemblers (especially when the time for assembling LCD sets is a fraction of that for CRTs), than to build and ship thousands of TVs from a single location. However, new LCD panel manufacturers, although having some success introducing TV sets to the US have not disrupted the traditional TV set brands remaining dominant in Europe.
- **Outsourcing** TV making appeared to be a long term trend, particularly to Turkey which has had low cost producers and a beneficial duty arrangement with the EU. The modularisation and standardisation of internal design elements, for example the wider availability of suitable chips, allowed Original Equipment Manufacturers (OEM) and Original Design Manufacturers (ODM) to build sets more easily, making outsourcing of design and/or manufacturing a more viable option. However, although still present globally (iSupply suggest contract manufacturers will globally produce 38% of LCD-TVs in 2010, up from around 20% in 2008) this trend has reversed in Europe in favour of more vertical integration and the proportion of FPD TVs being made by OEMs in Turkey is reducing compared to when CRTs were dominant.[23].
- **Advances in Logistics** Whereas previously suppliers had to be located near assembly plants, advances in logistics allow the efficient co-ordination of global shipments, although there is still a cost associated with any relative lack of transport and logistics infrastructure in specific locations.
- **Component and material specialisation**. Many sources particularly in Asia are growing in scale and specialisation to reduce costs or to integrate additional features. Asian suppliers dominate the development and manufacture of LCD cells for example. This requires strategic procurement for example in Asia to better manage supply relationships.

6.2 Supply Chain Routes for TVs entering the UK market – major producers

6.2.1 Major TV Producers

Commercially available research sources suggest the following seven brands represent at least 60% of supply and 80-90% of retail sales of TVs in the UK:

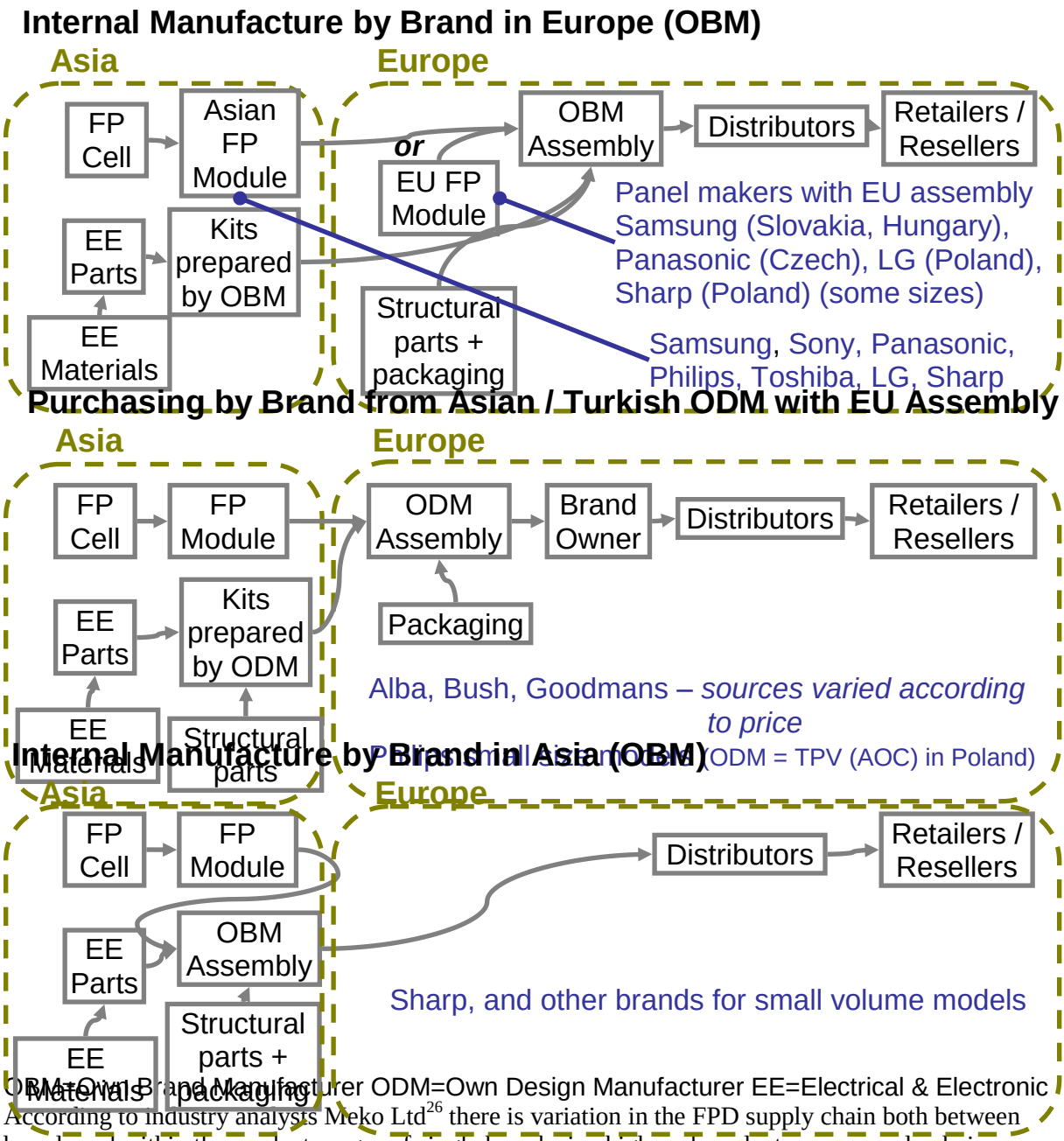
- Ranked by volume; Samsung, Sony, Panasonic, Philips, Toshiba, LG Electronics, Alba (+ Bush + Goodmans) and Sharp.
- Ranked by sales value; Sony, Samsung, Panasonic, Philips, LG Electronics, Alba (+ Bush + Goodmans) ,Toshiba and Sharp.

[22] MOUGAYAR, William. *Small Screen, Smaller World.* YaleGlobal Online, 11 October 2002, 2002 [cited 27 March 2008]. Available from <http://yaleglobal.yale.edu/display.article?id=204>.

[23] DisplayCast, Special Report, *FPD TV Assembly in Europe*, Meko Ltd, November 2006

6.2.2 Supply Chains

The following figure shows the main variants in supply chains for at least the major seven flat panel TV brands entering the UK market – source Meko Ltd[24] [25].



OBM=Own Brand Manufacturer ODM=Own Design Manufacturer EE=Electrical & Electronic

According to industry analysts Meko Ltd[26] there is variation in the FPD supply chain both between brands and within the product ranges of single brands; i.e. high-end products use a supply chain model with brand-owned manufacturing, whereas, lower-end products use other supply chain models.

6.2.3 Vertical Integration

In the days when CRT was the dominant TV technology, there was very strong vertical integration, with almost all of the major CRT TV brands (Sony, Samsung, LG, Philips, Thomson, Panasonic,

[24] DisplayCast, Special Report, *FPD TV Assembly in Europe*, Meko Ltd, November 2006

[25] WOOLMAN Tim, Personal Correspondence with Meko Ltd, 11 July 2008

[26] WOOLMAN Tim, Personal Correspondence with Meko Ltd, 11 July 2008

Toshiba etc) having their own CRT factories in Europe and supplying the vast majority of tubes for their own products, with lower-end sets coming from Turkey. This structure is now changing as the market for FPD TVs grows.

Samsung, LG, Panasonic and particularly Sharp in Japan, have once again strengthened their vertical integration in LCD TV manufacturing. Sony has major investment in LCD panel making with Samsung and forthcoming supply will be from Sharp.

By contrast, Philips concentrates on selling to the market , moving away from vertical integration to use a model more like a PC manufacturer, buying panels from 'merchant suppliers and assembling them using OEMs working under licence e.g. TPV (AOC) for LCD TVs. Merchant suppliers of panels who do not have their own TV manufacturing include AU Optronics and CMO from Taiwan.

6.3 Manufacturing Locations

Manufacturing locations and the associated chain of suppliers are changing according to market dynamics and duty rates. For example, Hitachi moved their main manufacturing base from Japan to the EU, but then moved on the Philippines and then to China. The next move could be to North Africa because, should developing countries impose high duty rates on finished goods but not on components, this strategy may encourage multi-national companies to invest in assembly plants in their economies.

6.3.1 Manufacturing in Europe

TV manufacture close to the large European market includes a trend to establish LCD panel (module) manufacture partly through vertical integration within Europe, notably in Central European locations; Poland, the Czech Republic, Hungary and Slovakia. CRT manufacturing has become uncompetitive in Europe due to the very capital-intensive requirements as production lines are specialized for specific screen sizes.

TV assembly, which was previously located in areas such as the UK (Sony, Hitachi and LG in Wales for example) and Spain, is now being relocated to be near the flat panel makers. Panel makers in Europe include Sharp (Poland), LG Display, (Poland), IPS Alpha-Panasonic (Czech Republic), Samsung (Slovakia) and Samsung SDI (Hungary) and AUO-Qisda (Czech Republic).[27]

Notable brands manufactured in Europe (many headquartered in Asia) currently include:

- Sony (Japan) – Barcelona, Spain and Nitra, Slovakia (following 10 years experience in Trnava, Slovakia [28]; 3m LCD TVs to be produced in Slovakia in 2008, increasing to 5m)
- Samsung (South Korea) – Hungary, Slovakia, Czech Republic (4m FP TVs, no CRTs since 2004)
- Panasonic (Japan) – Plzeò, Czech Republic since 1996 (LCD and PDP since 2004)
- Philips (Netherlands) – Hungary, Belgium, Czech Republic (divested to joint venture)
- LG Electronics (South Korea) – Wroclaw, Poland (LG Display joint venture with Philips)
- Toshiba (Japan) – Plymouth, UK and Poland (LCDs only)
- Hitachi (Japan) – Žatec, Czech Republic from 2007 (also PDP modules)
- Sharp Electronics (Japan) – Poland, Spain
- JVC (Japan) – Poland
- Videocon (Italy) - Italy

[27] RAIKES Bob – Meko Ltd, Commercial-In-Confidence Presentation to Defra, *TV Supply Chain to the UK*, July 2008

[28] Sony Europe. *Sony Europe to Establish A New Plant for LCD TV Manufacturing in Nitra, Slovakia*. Press Release ed. Berlin: , 20 September 2006, 2006 [cited 13 June 2008]. Available from <http://www.sony-europe.com/view/ShowPressRelease.action?section=ODW+SS+en_EU+Press&pressrelease=1158155178741&site=odw_en_EU>.

- Beko plc (Turkey) – Turkey (also an OEM/ODM and with an investment in Grundig)
- Changhong Electric Co Ltd (China) - Czech Republic (also an OEM/ODM and panel maker)

Only Toshiba, Pioneer and Sanyo (small volume) have been manufacturing TVs in the UK in recent years, reflecting the typical moves to relocate production from the UK, Spain, France, Italy, Germany and notably Turkey (Beko and Vestel as OEMs in Turkey previously made many of the TVs in Europe) to Central and Eastern Europe.

Some brands such as Alba and Goodmans have also been sourcing TV sets or a proportion of their product range from Original Equipment Manufacturers (OEM) or Own Design Manufacturers (ODM). Those with factories in or near the EU include;

- Vestel – Turkey (OEM/ODM)
- Tatung – Czech Republic (OEM)
- TPV(AOC) – Poland (OEM/ODM)
- Funai – Poland (OEM/ODM)
- Qisda - Czech Republic (OEM/ODM)

The variants in TV designs required for the different specific requirements of a range of countries within Europe are difficult for ODMs based in Asia to cater for, which favours the brands with design capabilities within Europe.

Import data for TVs supplied to the UK market confirms the proportion of supply from major assembly/manufacturing in these locations. The following table of UK TV import data for 2007 is from UK HM Revenue & Customs UK Trade Info[29]. These figures should be treated as estimates given the uncertainty in classifying FP TVs confounded with other forms of FP Display such as PC monitors with video inputs. Approximate unit quantities can be inferred from these proportions, using an overall figure of 6.4 million FP TVs being placed on the UK market; 70-85% from the EU, 8-15% from Turkey and around 8% from Asia – source Meko Ltd. [30]

	Weight (Kg)	Weight %	Value (£)	Value %
World Total	2,0530,2492	100%	2,069,305,694	100%
Top 10 Locations importing to UK	**202,840,769**	**99%**	**2,020,017,382**	**98%**
Spain	67,217,866	33%	487,658,534	24%
Slovakia	52,029,359	25%	411,156,998	20%
W. Europe (excl. EU 27)	23,893,581	12%	278,911,911	13%
Hungary	17,705,669	9%	197,548,622	10%
Poland	14,746,503	7%	225,288,812	11%
Asia & Oceania	10,346,125	5%	118,058,724	6%

[29] HM Revenue & Customs *UK Trade Info : UK World Trade 2007 – 8 Digit.* HM Revenue & Customs. , 2008 [cited 16 June 2008]

[30] RAIKES Bob– Meko Ltd, Commercial-In-Confidence Presentation to Defra, *TV Supply Chain to the UK*, July 2008

Czech Republic	8,924,913	4%	177,546,771	9%
Netherlands	3,609,445	2%	54,972,986	3%
Germany	2,447,055	1%	35,811,530	2%
France	1,920,253	1%	33,062,494	2%

The above UK TV import figures are dominated by LCD and Plasma TVs (Commodity code 'Comcode'[31] 85287291 for 4:3 or 5:4 screen TVs and 85287299 for 16:9 screen TVs). Within the above figures there are a small proportion of CRT TVs (aggregated from Comcodes 85287231, 85287233, 85287235, 85287239, 85287251, 85287259, 85287275). [32]

	Weight (Kg)	% of all TVs Weight	Value (£)	% of all TVs Value
World Total	16,014,174	8%	134,185,965	6%
Top 10 Locations	15,522,668	8%	128,564,364	6%
Asia & Oceania	4,514,480	2%	27,519,527	1%
W Europe (excl. EU 27)	4,331,292	2%	19,284,307	1%
Slovakia	2,219,567	1%	20,142,327	1%
Netherlands	2,068,962	1%	30,487,788	1%
Hungary	800,823	0%	9,385,353	0%
Poland	664,990	0%	7,703,632	0%
Czech Republic	524,504	0%	9,846,029	0%
Other America	177,593	0%	438,312	0%
Germany	176,251	0%	3,162,700	0%
Middle East & N.Africa (excl.EU27)	44,206	0%	594,389	0%

Growth of TV final assembly in Central and Eastern Europe

Moving final assembly to Central and Eastern Europe is partly driven by the EU's duty regime, putting 14% duty on TVs coming from outside the EU or from countries without a customs agreement with the EU (for example Turkey is rated at 0%). The additional cost to carry out the final assembly of TVs in Europe (5% or 6% estimated by Meko Ltd[33]), is weighed against the 14% duty.

Also facilitating this shift of final production is the recent accession of Eastern European countries to the EU, which is likely to encourage greater trading integration through coordinated systems and growth in trade representatives working between countries. Transport logistics and some skills remain an issue. For example, Funai moved TV production to the Baltic States and then moved to Poland.[34]

Within the areas exempt from import duty to the UK, Central Europe, notably Poland, the Czech Republic and Slovakia have been preferred locations because of the following factors:

- Proximity to Western European markets.
- Skilled labour supply and costs.
- Logistics – dependent on transportation infrastructure.

[31] Business Link UK *Trade Tariff >Commodity > Heading 8528*, 2008 [cited 16 June 2008] Available from: http://www.businesslink.gov.uk/bdotg/action/tariffFilter?export=false&key.commodityCode=8528000000&r.s=sl&simulationDate=26/6/08#8528000000

[32] HM Revenue & Customs *UK Trade Info : UK World Trade 2007 – 8 Digit.* HM Revenue & Customs. , 2008 [cited 16 June 2008] Available from: http://194.223.26.124/HMRC/TableViewer/tableView.aspx?ReportId=398.

[33] DisplayCast, Special Report, *FPD TV Assembly in Europe*, Meko Ltd, November 2006

[34] RAIKES Bob– Meko Ltd, Commercial-In-Confidence Presentation to Defra, *TV Supply Chain to the UK*, July 2008

According to DisplaySearch[35] 28.95 million TV sets will be produced in the Czech Republic, Hungary, Poland and Slovakia together in 2008. These are mostly for export - demand is currently less than 12 million sets in all of Central and Eastern Europe, Russia and Turkey combined. Production in Central Europe is set to rise by 6 million units, to 35 million, by 2011. Thirteen million TVs will come from the Czech Republic.[36] Locating farther east, for example to the Baltic States would achieve lower labour costs, but transport costs would be higher.

6.3.2 Manufacturing in China

As the import figures in above tables show, Asia including China is not currently a significant direct exporter of TV sets to the UK, although very limited data suggests China leads amongst Asian import locations. Exports of TVs to the UK from China by major companies include the following.[37]

Company	Export quantity (2007)
Haier group	225,605
Konka Group Co. Ltd	31,342
Xiamen Overseas Chinese Electronic Co., Ltd. (Xoceco)	3,875
Shenzhen (Skyworth)-RGB Electronics Co., Ltd	1,814
Hisense Electric Co., Ltd	432
Above companies total TV exports to UK (2007)	263,068

CRT production has moved to Eastern Asia, mainly to China, making relatively large CRTs uneconomic to ship to Europe. Some smaller FP TVs and CRTs are still supplied from Asia when it is not economic to establish manufacturing local to the EU market.

However, many components, such as flat panel cells and modules made in China, can be shipped economically to Europe for assembly into TV sets, as discussed below. Changes to the EU import duty for LCD panels (currently suspended to 0%) may determine how competitive it becomes for Chinese TV set manufacturers to exploit the growing Chinese production of FP modules and cells.

6.4 Component Supply

The main types of components for the predominant designs, LCD and PDP flat panel TVs manufactured in Europe can be broadly categorised in terms of their supply. (Panels are LCD or PDP Modules comprising the LCD or PDP Cell, with the filter, the backlight (LCD) and the electronics.)

According to Meko Ltd[38], the top five manufacturers of panels, representing more than 80% of panel manufacture are Samsung (Korea), LG Display (Korea), AU Oprtonics (Taiwan), Chi Mei Opto (Taiwan), Sharp (Japan) and Panasonic (Japan). Around 70% of the production costs of an LCD and around 60% of a PDP TV set are associated with the panel. This favours TV set brand companies that can control the costs in this element of manufacturing, for example through vertical integration with panel manufacture.

[35] Display Search, TV Products Information Page http://www.displaysearch.com/cps/rde/xchg/SID-0A424DE8-71CAA55C/displaysearch/hs.xsl/products_tvs.asp

[36] BODNÁR, Marcel. *TV Makers Give Central Europe High Ratings*. Czech Republic: , 2008 [cited 28 May 2008]. Available from <www.cbw.cz/en/tv-makers-give-central-europe-high-ratings/7621.html>

[37] WOOLMAN Tim, Personal correspondence with China Household Electrical Appliances Association, China export statistics, 28 April 2007.

[38] RAIKES Bob – Meko Ltd, Commercial-In-Confidence Presentation to Defra, *TV Supply Chain to the UK*, July 2008

The location of panel module manufacturing is following the trend towards Central Europe – see Growth of TV Final Assembly in Central and Eastern Europe. Apart from the proximity to TV final assembly, integrating expensive components (backlighting, filters and electronics added to the Cells) later in the build i.e. in Module assembly, delays adding value to the inventory of sub-assemblies until the cell arrives in Europe, typically from Asia. With the share of material costs increasing as manufacturing efficiencies have improved, this delayed investment in the later stages of build potentially releases cash in TV producers (while increasing inventory costs for component suppliers).

A generalised account of manufacturing locations for the sequence of components built into assemblies is summarised below:

- **Small components with some manual content** - e.g. transformers, typically from China.
- **Sub-component supply for circuit boards** - supply depends on type. For example;
    - high technology e.g. small chips from Japan, some from China depending on quality.
    - automated production e.g. capacitors, from Asia e.g. Malaysia (automation investment).
- **Main circuit boards** - source varies with manufacturer, with some from China for example
- **Cells and arrays for LCD** - all come from Asia; Korea, Taiwan and Japan, with a small proportion from China (the technology and skills are concentrated in Asia and the process is highly automated)
- **Cells and arrays for PDP** - manufacture is mainly in Japan and Korea
- **Modules** - assembling Cells with backlights, filters, electronics etc; is mainly located in China with some companies establishing in Europe (manual assembly)
- **Structural and external parts** - e.g. metal mounting components and plastic enclosures – sourced local to manufacturer - e.g. in Europe, due to wider availability and cost of shipping relatively bulky items.

Consumer demand for flat panel TVs has emerged as the driver of the growth of;

- large-sized LCD and PDP panels,
- semiconductors such as display-driver integrated circuits, and general-purpose logic parts (FP TVs have a 2.5 times greater semiconductor content than analogue sets), with a consequent increase in demand for materials associated with these components.

6.5 Materials

Very few TV Life Cycle Assessments (LCAs) are available to refer to in the public domain. The limited few that are available are for the older CRT technology. Even within TV manufacturers, material constituents for assembled TVs are not collated through assembly, sub-assembly, component and material declarations from lower to top supply chain tiers in the same way as the automotive International Material Data System[39]. The following sources suggest an indicative range of materials, notable for the aspects of rarity or environmental significance. TV component suppliers may source these from a number of locations - TV specific data is not available.

The environmentally significant content of a typical LCD TV, as shown by an Environmental Product Declaration (EPD) [40], is shown below.

Material	Weight Percentage	Note
Steel	47.25%	
Copper	0.33%	

[39] International Material Data System. EDS., 2008 [cited 19 June 2008] Available from:<http://www.mdsystem.com/html/en/home_en.htm>.

[40] LG.Philips LCD. Certified Environmental Product Declaration Product : TFT-LCD Module. LG.Philips LCD. , c. 2005 [cited 16 June 2008]. Available from <http://www.environdec.com/reg/e_epd95.pdf>.

EPS	6.17%	
PMMA	7.63%	
PET	7.40%	Part of packaging
PC	6.35%	
PE	0.70%	Part of packaging
Glass	4.52%	
Paper	8.69%	Part of packaging
Electronics	0.92%	

Material related environmental impacts for these materials are given in EuP Preparatory Study "Televisions" Lot 5.[41]

6.5.1 Hazardous substances

The following table shows major hazardous substances in a range of TV types, noting those controlled by the European RoHS requirements marked*.[42]

Hazardous Substance	**CRT**	**PDP**	**LCD**	**OLED**
Phosphors	√	√		√
*Lead solder	√	√	√	√
*Lead	√	√		
*Mercury			√	
Flame retardants eg Tetra-bromo bis-phenyl A (TBBPA)	√	√	√	√
*Hexavalent Chromium	√	√	√	√
Poly-vinyl Chloride	√	√	√	√
Bismuth	√	√	√	√

6.5.2 Nitrogen Triflouride

Recently attention has been drawn by a number of press[43] and academic journal[44] articles to the potential environmental effects of Nitrogen Triflouride (NF_3) and Sulphur Hexafluoride SF6 used for etching the silicon in LCD modules such as those in TVs, among other applications such as computer monitors and laptop screens. Michael Prather, University of California, suggests the global warming potential (NF_3 is 17,000 times more potent than carbon dioxide) could be significant due to the growth in production of consumer electronics, especially flat panel TVs, driving a projected doubling in production of the gas from the current 4,000 tonnes produced annually. Industry sources suggest very little of the gas is released into the atmosphere but reduced to solid form for disposal instead. However Toshiba Matsushita Display Technology has chosen to avoid using the gas.

Currently, NF_3 is not controlled under the Kyoto Protocol or the United Nations Framework Convention on Climate Change. Defra has commented that work is underway with other members of

[41] Fraunhofer IZM; and PE Europe. EuP Preparatory Studies "Televisions" (Lot 5) : Final Report on Task 5 "Definition of Base Cases". . STOBBE, Dr Lutz ed., Berlin: Fraunhofer Institute for Reliability and Microintegration, IZM. , 2007 [cited 12 May 2008]. Available from <http://www.ecotelevision.org/docs/Lot%205_T5_Final_Report_02-08-2007.pdf>.

[42] WHITE, Paul, et al. *Environmental, Technical and Market Analysis Concerning the Eco-Design of Television Devices.* Spain: Institute for Prospective Technological Studies. , 2006 [cited 17 June 2008]. Available from <http://ftp.jrc.es/EURdoc/eur22212en.pdf >. ISBN 92-79-01865-5.

[43] The Guardian, *Environment: Climate risk from flatscreen TVs*, 3 July 2008

[44] PRATHER Michael J. and HSU Juno**,** *NF3, the greenhouse gas missing from Kyoto* , Geophysical Research Letters, VOL. 35, L12810, doi:10.1029/2008GL034542, 2008. http://www.agu.org/pubs/crossref/2008/2008GL034542.shtml

EU to ensure that all new synthetic greenhouse gases, including NF_3, are covered as part of any future UN climate change agreements, potentially within a new global climate treaty in Copenhagen (2009).

At this stage, the environmental impact from manufacturing LCD TVs cannot be readily quantified.

6.5.3 Rare substances

A TV's consumption of copper and (prior to RoHS) lead are significant. For CRT TVs the use of lead shielding far outweighed the lead used in solder. Strontium was also a notable constituent of CRTs. Global demand for copper is estimated to outstrip the amount extractable by the year 2100.[45]

Information emerging from recent recycling conferences in Europe have highlighted the use of rare substances such as europium in red phosphors, currently not recovered at end-of-life.

Global modelling of mineral use presented by the UK Environment Agency[46] suggests that by 2050:

- Iron, Molybdenum, Tungsten, Cobalt, Platinum, Palladium will be close to exhausting current economically feasible reserves
- Nickel, Manganese, Lithium, Indium, Gallium will be extracted beyond their current economically feasible reserves
- Copper, Lead, Zinc, Gold, Silver, Tin will have 'run over' the amount of their reserve base (the current economically feasible reserves plus those currently not economic to extract.)

Material security is discussed in more detail in the Resource Efficiency Knowledge Transfer Network (KTN) report 'Material Security Ensuring resource availability for the UK economy'[47].

Demand for indium consumed by the LCD industry has caused the tightening of indium supply and subsequent steep price increases, with further pressure from the closure of several mines in the Nandan region of China. This suggests indium demand would outstrip global primary production capacity, perhaps even with new capacity in Korea.[48] to add to the sources in North America and Russia (see section 6.5.4). Global supply could be exhausted by 2017, although estimating the extractable reserves of many such metals is difficult, for indium these figures are kept confidential by mining companies.[49]

6.5.4 Global Sources of Materials

As above, information sources which can explicitly link material constituents to TVs are limited in the public domain and further information to locate the range of global sources of material supply for a representative set of components, is not available even within TV manufacturers and analysts.[50]

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[45] COHEN, David. *Earth's Natural Wealth: An Audit*. [New Scientist Environment]Reed Business Information Ltd, 2007 [cited 13 June 2008]. Available from <http://environment.newscientist.com/article.ns?id=mg19426051.200&print=true>.

[46] LEVESON-GOWER, Henry; and PEAL, Alex. Material Security and Climate Change. Presentation to 2nd UK - Japan workshop on materials security ed. Southampton: , 2007 [cited 13 June 2008]. Available from <http://ren.globalwatchonline.com/epicentric_portal/site/UKREN/menuitem.a584c6a32b46321afc6ab5de8380e1a0/?mode=0>.

[47] MORLEY, Nick; and EATHERLEY, Dan. Material Security : Ensuring Resource Availability for the UK Economy. March 2008, 2008 [cited 16 June 2008]. Available from <http://ren.globalwatchonline.com/epicentric_portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/UKREN/UKREN%20Public/documents/material_security.pdf>. ISBN 978-1-906237-03-5.

[48] O'NEILL, Brian. Indium : Supply, Demand & Flat Panel Displays. Paper presented at Minor Metals 2004, London, June 2004 ed. , 2004 [cited 13 June 2008]. Available from <www.nrel.gov/pv/thin_film/docs/indium_supply_and_demand%5B1%5D.doc>.

[49] COHEN, David. *Earth's Natural Wealth: An Audit*. [New Scientist Environment]Reed Business Information Ltd, 2007 [cited 13 June 2008]. Available from <http://environment.newscientist.com/article.ns?id=mg19426051.200&print=true>.

[50] RAIKES Bob – Meko Ltd, Commercial-In-Confidence Presentation to Defra, *TV Supply Chain to the UK*, July 2008

Glass supply for larger FPD screens is dominated by Corning, and sourced locally to the FP Cell fabrication i.e. in the Far East. Other materials related to TV supplies can be very speculatively related to the following global reserves, as reported in New Scientist[49] .

Mineral	**Major Source Locations** for reserves >= 5% of world totals	**World Totals**
Copper	Chile (38%), US (7%), China (7%), Peru (6%), Poland (5%), Australia (5%)	937 million tonnes
Gold	South Africa (40%), Australia (7%), Peru (5%), China (5%)	89,700 tonnes
Indium	Canada (33%), China (22%), US (10%), Russia (5%)	6,000 tonnes
Lead	China (25%), Australia (19%), US (14%), Canada (6%), Kazakstan (5%)	144 million tonnes
Platinum / Rhodium	South Africa (88%), Russia (8%),	79,840 tonnes
Silver	Poland (25%), China (21%), US (14%), Australia (7%), Mexico (7%), Peru (7%), Canada (6%)	569,000 tonnes
Zinc	US (20%),China (20%),Australia (17%),Kazakhstan (8%),Canada (7%),Mexico (5%)	460 million tonnes

As discussed in the next section, recovering materials from various waste streams could in future provide valuable (and perhaps more localised) sources of rare materials for use in TV or other manufacturing supply chains.

6.5.5 Material Aspects

Evaluation of the environmental impact of materials and their supply is difficult to determine with a limited evidence base, although there may be greater impacts than suggested in the EuP Study with respect to:

- raw materials -.mining and transportation of raw materials from global sources, resource depletion of rare substances,
- manufacturing production - hazardous substances and emissions to air, and,
- end-of-life - hazardous and non hazardous waste materials.

Further research is required, potentially in partnership with industry, to complete LCAs for flat panel TV designs with input from a sufficient range of suppliers typically located in Asia. Suppliers are otherwise unlikely to compile full material declarations for the complex range of components and sub-assemblies, with designs and sources constantly changing to meet market and supply chain demands.

6.6 Routes for UK TVs at end-of-life

At end-of-life, TVs - mostly CRTs at present – are collected as WEEE by Designated Collection Facilities (DCFs). TVs may be reused/recycled in the UK or exported for recycling/reuse – see Section 7.6 Waste Management Routes for Display Equipment, which shows the following:

- Reuse (10%)
- Exported (20%)
- Treated and recycled in the UK (70%)

A small proportion of TVs are returned e.g. under guarantee conditions, by retailers to distributors who in turn process the TVs as WEEE, return the TVs to manufacturers, or sell the TVs to a company which deals in used TVs.

Routes and processes at end-of-life are discussed in more detail in section 7, including the export of waste TVs (Section 7.5).

7 End of Life

7.1 Summary

Based on 2007 data, all end-of-life (EOL) TVs are separately collected at WEEE collection facilities set up as a requirement of the WEEE Regulations. These must be sent for treatment; none are landfilled. Currently, 99.99% of these TVs are CRT TVs. However, forecasts predict that numbers of EOL CRT TVs will decline to near zero and the TV waste stream will consist of entirely flat screens by 2020 and beyond. Data supplied to the Environment Agency indicates that today's CRT TV waste goes to the following routes:

- Reuse 10%
- Exported 20%
- Treated and recycled in the UK70%

There appears to be adequate capacity in the UK for the proper recycling of CRTs. Despite the predictions that flat screen will start appearing in the TV waste stream in ever larger quantities, recyclers are currently unsure how best to deal with these devices. The WEEE Directive has the following requirements for EOL LCD TVs:

"Removal of LCDs (together with their casing if appropriate) if either:

- they have a surface area greater than 100 square centimetres (i.e. larger than 4 inches by 4 inches), or
- they are back-lighted with a gas discharge lamp."

A number of different recycling processes are under development, but there is currently no favoured BAT (Best Available Technology) treatment.

Export of EOL TVs is a largely unknown area in terms of evidence although opinion abounds. Reports in the press[51] suggest that TVs amongst other equipment is being exported to Africa in an 'illegal trade worth £7m a year'. The difficulty with such headline stories though is that they do not adequately differentiate between a legal export activity that sees the TV reused or the illegal activity where it is broken up and recycled and or dumped.

A similar story was carried by the Ethical Corporation in November 2007[52] saying that there is a world trade in used electronic equipment including TVs much of which, under the guise of charitable donations, ends up in Africa. Of this total, some 500 containers per month arrive at Lagos, Nigeria each month. The article adds that the United Nations Environment Programme (UNEP) believe this is but a fraction of the 50 million tonnes of e-waste finding its way to Africa each year.

Anecdotally it is worth mentioning that as a result of press coverage Greenpeace launched its 'Guide to Greener Electronics' league table of electronics companies. Some firms have responded with projects to better understand where the electronic waste originates and what people are doing with it. Both HP and Vodafone are targeting in-country recyclers to assist them to recycle products more efficiently and safely.

[51] For example, The Guardian *Dumped computers and TV sets sold illegally to developing world* , 30 June 2004

[52] www.ethicalcorp.com

7.2 Amounts Collected

It is important to note that WEEE product categories in the UK differ to those in other member states in that televisions are included in Category 11 rather than in Category 4.

In May 2008, the Environment Agency published its revised WEEE data returns for the six month period July 2007 to December 2007. The amounts of WEEE collected (see Table 13 below) indicate that there could be around 89,000 tonnes of display equipment requiring annual treatment (assumed twice the July to December figure for collected category 11 'Display Equipment').

Table 13 - WEEE Collected in the 6 months July to December 2007[53]

No.	Category Name	Household WEEE collected from a DCF[54] (tonnes)	Household WEEE returned under regulation 32[55] (tonnes)	Total separately collected household WEEE	Non-household WEEE (tonnes)	Grand total Collected (tonnes)
1	Large Household Appliances	49605	10789	60395	2697	63091
2	Small Household Appliances	6423	90	6514	159	6672
3	IT and Telcomms Equipment	6114	278	6393	3746	10139
4	Consumer Equipment	6260	44	6304	25	6329
5	Lighting Equipment	16	0	17	37	53
6	Electrical and Electronic Tools	2558	897	3455	43	3498
7	Toys Leisure and Sports	71	103	174	224	398
8	Medical Devices	0	2	2	209	211
9	Monitoring and Control Instruments	164	2	166	69	235
10	Automatic Dispensers	0	0	0	648	648
11	Display Equipment	43780	269	44049	463	44512
12	Cooling Appliances Containing Refrigerants	53824	4438	58263	925	59188
13	Gas Discharge Lamps	261	46	307	2508	2815
	TOTALS	**169078**	**16959**	**186037**	**11752**	**197789**

(Note: Categories 11, 12 and 13 are not categories specified by the WEEE Directive. The separate reporting of these types of equipment are required by the UK's interpretation of the Directive as the WEEE Regulations)

No breakdown information by type of display equipment is recorded. However, the bulk of this display equipment waste is currently dominated by CRTs. Assuming an average weight of CRT displays of 20-25 kg, the annual number of displays would be between 3.5 and 4.5 million units. These numbers are in rough agreement with the total disposal of TVs in 2007 estimated by MTP[56] (see Figure 3 and Figure 4 below).

[53] Source: Environment Agency, 19/5/2008.

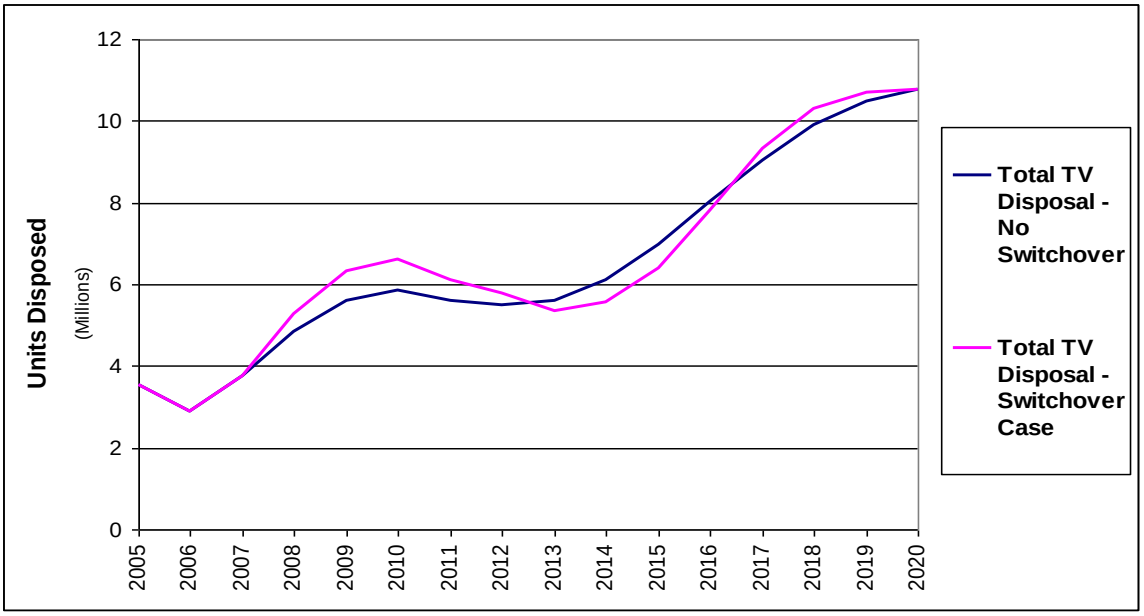
http://www.environment-agency.gov.uk/business/1745440/444663/1106248/2028265/?version=1&lang=_e

[54] This figure includes both household WEEE from Designated Collection Facilities (DCFs) that has been collected by Producer Compliance Schemes, and household WEEE that DCFs have cleared themselves. All DCFs clearing their own WEEE have not yet provided data. The Agency are working to get a complete set of data.

[55] This figure includes household WEEE returned by distributors to Producer Compliance Schemes and household WEEE collected through a collection system a Producer Compliance Scheme operates itself.

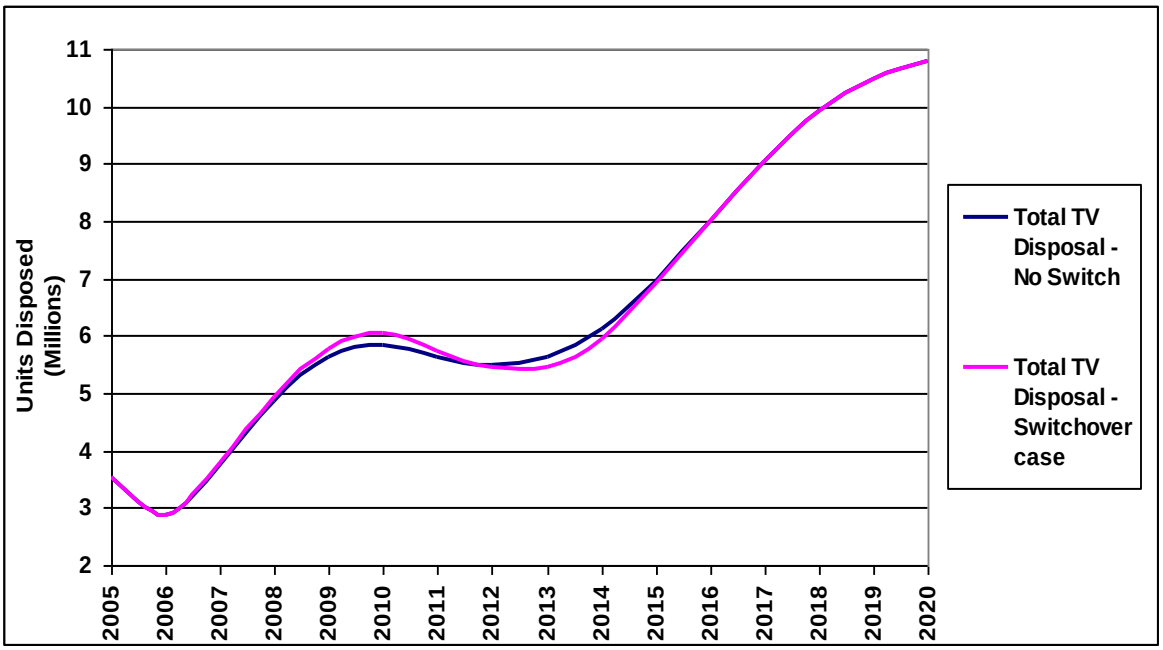
[56] Disposal of TV equipment: possible impact of digital switchover, MTP Project Report January 2007, Authors: Matthew Armishaw, Sarah Winne & Mike Blanch.

Figure 3 - Total UK television disposal: maximum possible disposal



(Source: MTP, *Disposal of TV equipment: possible impact of digital switchover*, Project Report January 2007)

Figure 4 - Total UK television disposal: minimum possible disposal



(Source: MTP, *Disposal of TV equipment: possible impact of digital switchover*, Project Report January 2007)

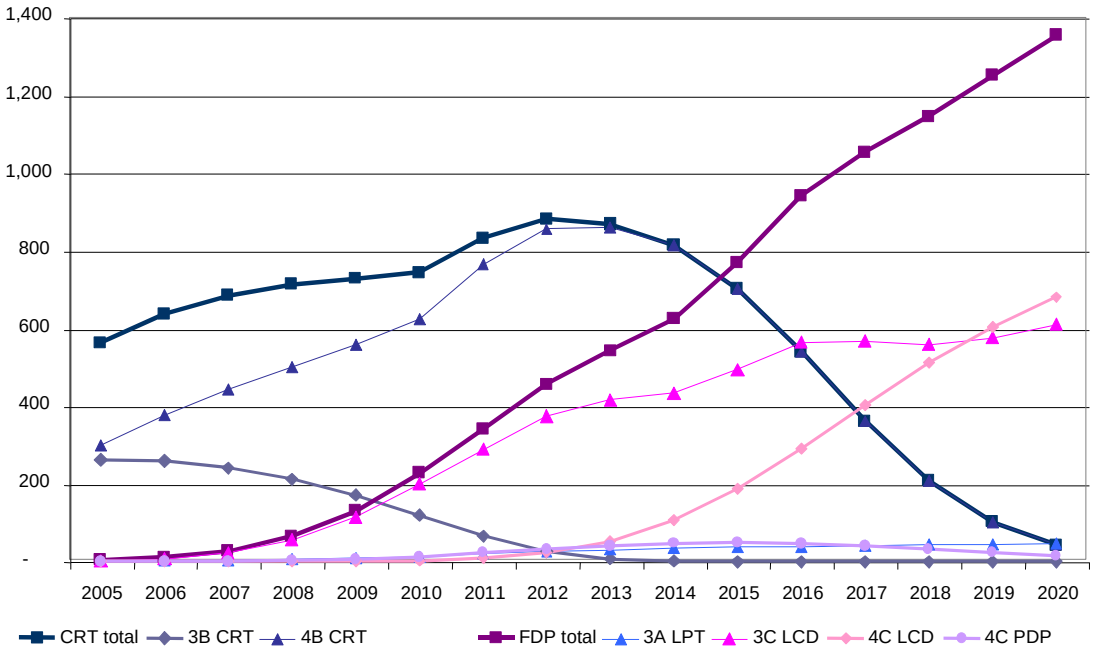
At present, the numbers of flat screens arising in the WEEE waste stream (e.g. at Designated Collection Facilities (DCFs)) are very small. A sample of recyclers[57] report they are not receiving large quantities of flat screen displays currently, and those that do receive tend to be either damaged or faulty items rather than being in the strictest sense 'end-of-life'. Such TVs are dismantled in compliance with the WEEE Regulations. One recycler, indicated that whilst they were treating over 700,000 CRT units per year, only a few hundred flat screens were handled (i.e. much less than 1 screen in 1000 received were flat screens).

[57] Personal communications with Sims Group, EMR Ltd., Wincanton, Shore Recycling, Axion Recycling, & Axr Group.

Anecdotal evidence suggests that the failure rates of flat screens within the guarantee period are typically 2-3% of sales[58]. It is not known whether or not these items reach the waste stream but are most likely returned initially to the retailer/manufacturer.

With regard to future predicted quantities, the StEP Initiative[59] has estimated the likely arisings of screens in kilo tonnes for the EU27 from 2005 to 2025 (see Figure 5 below. [Note: LPT = Laptop screens]). Tonnage arisings of CRTs are expected to peak around 2012 then 'tail away' towards 2020. Whereas, flatscreen tonnages (FDP) are expected to show continued increases throughout the period 2008 to 2020. With an estimated annual waste arising of CRTs of 89,000 tonnes, the graph below would suggest that the UK accounts for nearly 13% of the total EU27 CRT arisings in 2007.

Figure 5 - Kilotonnes of panels to be treated per year - EU 27 from 2005 - 2025



(Source: StEP)

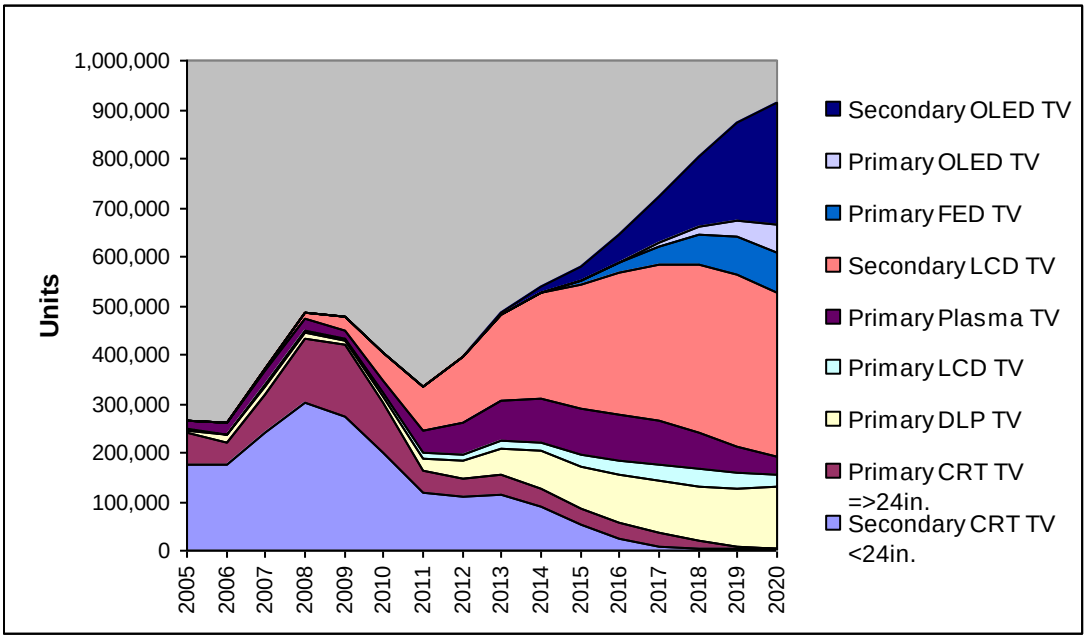
The shape of the curves for CRT Total and FPD Total in the above graph is in general agreement with the estimates made by MTP for the Anglian region of the UK (see Figure 6 below). However, there is disagreement over the year when disposal levels of CRTs reach a maximum, with the MTP estimate being about four years before the StEP estimate.

[58] Gerrard Fisher, WRAP.

[59] StEP *Solving the –Waste Problem* www.step-initiative.org

StEP is an initiative founded by various UN organizations and coordinated by UN's research arm, the UNU. Its overall aim is to develop strategies to solve the e-waste problem through global, regional & local projects. StEP draws its membership from industry, government, international organizations, NGOs and academia

Figure 6 - Television disposal by type in the Anglia region



(Source: MTP, *Disposal of TV equipment: possible impact of digital switchover*, Project Report January 2007)

7.3 Treatment of End of Life Display Equipment

7.3.1 Cathode Ray Tubes

The remanufacture of CRTs is not viable in the UK[60] because the UK market for CRT displays is disappearing rapidly. Hence CRT TVs will either be broken up and recycled or potentially, if they still function, exported as a good.

The Industry Council on Equipment Recycling (ICER) produced a number of reports on end-of-life (EOL) management of Cathode Ray Tubes (TVs and monitors), including:

- '*New Approach to CRT Recycling*', for DTI, August 2003
- '*Materials Recovery from Waste CRTs*', for WRAP, March 2004

These reports, although a few years old now, describe in detail the technologies available and the recovery potentials from CRTs. Some recyclers use a combination of manual dismantling (e.g. to remove the surrounding, printed circuit boards, yoke coils etc.) and crushing of the glass prior to separation of the phosphors and different glass types. Other recyclers employ specialist plant for cutting the CRT glass front panel from the cone and electron gun assembly. There is no consensus, as yet, on which technique is regarded as best available technology (BAT) but it is unlikely that crushing/shredding would be regarded as BATTRT (Best Available Treatment, Recovery and Recycling Technique) if mixing and contamination of the various fractions preclude recycling of the glass[61].

The typical material breakdown of a CRT based TV is shown in the Table 14 below:

[60] "Visual Displays CRT, LCD and Plasma Screens Remanufacture", Oakdene Hollins, August 2006.

[61] Defra, "Guidance on Best Available Treatment Recovery and Recycling Techniques (BATTRT) and treatment of Waste Electrical and Electronic Equipment (WEEE), November 2006.

Table 14 - Breakdown of a Typical CRT-based TV

TELEVISIONS Aggregated figures	(19" and over)			
Component	**Potentially Hazardous Constituent Substances**	**Potentially Hazardous Constituent Substance % of component**	**Component % of total product**	**Potentially Hazardous Constituent Substance % of total product**
CRT			**76.08%**	
	Lead Oxide	8.69%		**6.61%**
	Glass	67.13%		**51.07%**
	Cadmium metal	0.04%		**0.03%**
	Chromium VI	0.00%		**0.00%**
	Antimony Trioxide	0.22%		**0.17%**
Circuit Board			**5.56%**	
	TBBPA (Tetrabromobisphenol A)	14.50%		**0.81%**
All plastic			**14.44%**	
	TBBPA	14.50%		**2.09%**
Wires and other electrical			**1.59%**	
	TBBPA			
	Phthalate Plasticizer			
Other Copper	Copper		**2.33%**	**2.37%**
		TOTAL	**100.00%**	

(Source: WEEE & Hazardous Waste, DEFRA, March 2004)

Currently there are dozens of display equipment recyclers in the UK providing adequate treatment capacity for the current arisings. For example, one recycler alone claims to be processing over 700,000 units annually. Some recyclers claim to be achieving close to 100% recycling rates for the TVs they handle meaning that even the plastic fraction is being reused.

7.3.2 Flat Screens

AEA were commissioned by Defra to study "WEEE and Hazardous Waste" (Parts 1 and 2). Part 2, which completed in June 2006, involved dismantling trials of a range of EOL equipment. At the time, only one LCD TV was available for dismantling tests as flat screens were not turning up at waste sites (i.e. not reaching end-of-life) but being returned to manufacturers under guarantee conditions. The breakdown data for a 20-inch LCD TV is presented in Table 15 below.

Table 15 - Dismantling Data for a 20-inch LCD TV

Description of item	**Flat screen TV**	
Type	**20 inch LCD**	
WEEE grouping	**4**	**Percentages**
Weight of item before dismantling (grams)	**8640**	**%**
Time to dismantle (mins)	**25**	
Components (Weight in grams)		
Case		
Metal	2140	25.6%
Plastic	1470	17.6%
Other metal (describe)		
Screws etc.	1030	12.3%
Circuit board		
Weight	770	9.2%
LCD unit which can be removed, e.g. display for a portable computer	2210	26.4%
Removable back lights	30	0.4%
Other	612	7.3%
Other non electrical/electronic items		
Other	100	1.2%
Total weight after dismantling (grams)	**8362**	**100.0%**
Mass Balance (% difference)	**3%**	

About 85% of the weight of the LCD panel is glass[63]. The dismantling trials indicated that removal of the backlights (a requirement of the WEEE Directive – they contain mercury) was going to be a major time-consuming issue facing the WEEE management industry in the future.

The StEP Initiative (Jaco Huisman – UNU Bonn) has carried out some in-depth product analyses on LCD monitors and TVs. They show major difficulties with removing backlights and also large differences in product architecture. They concluded that manual dismantling is not an option due to risk of mercury (Hg) emissions. Shredding is also not an option as it will disperse the mercury. Thermal options are also not ideal as one loses valuable materials especially from contacts around the screen.

Possibilities for remanufacture of flat screens exist but are seriously hampered by the declining prices for these items in the market place reducing the profit margins that can be made from remanufacture[62]. Additionally, flat screens are an integrated unit, which makes remanufacturing more difficult (cf. CRT screens). Technical difficulties are reported too, for example, for flat screens with fine pitch connectors, replacement of edge tabs would need to be performed under clean room conditions posing cost implications.

Both Plasma and LCD screens can only be remanufactured if the screens are neither damaged, nor scratched, nor have pixel faults. Approximately 40% of flat screens returned are rejected for these reasons[62]. Most other returned flat screens have either backlight or electrical/electronic faults that are repairable. Given the decline in the new prices of flat screens, redeployment of old flat screens (e.g. for making large billboard displays consisting of arrays of panels) may be economically more viable than remanufacture.

Currently, for the few flat screens reaching recyclers, treatment is a manual task to remove the back-lights which are subsequently grouped with fluorescent tubes for onward treatment in specialised plant that can recover the mercury, glass, phosphors and end caps. A viable treatment technology is required to replace this relatively costly manual operation. For LCD screens, pyrolysis has been suggested as a possible viable solution; for plasma screens, it has been suggested that, because of the

[62] "Visual Displays CRT, LCD and Plasma Screens Remanufacture", Oakdene Hollins, August 2006.

similarity to CRTs, plants that recycle CRTs would develop processes to cater for PDPs (Plasma Display Panels)[63].

A special process for the disposal of LCDs has been operated by the Berlin company "VICOR" in a pilot plant, in which the displays are separated manually from casing and electronic parts and the polarisation films and subsequently shredded to a size of about 1 cm[64]. The liquid crystals are then distilled off in a furnace in a nitrogen/argon atmosphere at a maximum of 400° C. and atmospheric pressure. After condensation thereof in a cold trap, they are passed to final storage in an underground landfill site. The furnace temperature must not exceed 600° C. during the treatment since otherwise, owing to the molecular structure, there is a risk of dioxin formation. The other material fractions arising, namely glass, plastic and circuit boards, as well as structural elements are processed further by conventional recycling methods.

The disadvantage of this process is that the separation of the liquid crystals is technically very complex and very expensive because:

- they make up a very small proportion by weight of the total display (about 1 kg of liquid crystals per ton of displays),
- represent a mixture of different individual substances,
- the liquid crystals are subsequently disposed of to landfill.

Use of the recovered liquid crystals in new LCDs is considered uneconomic.

Recyclers report that dismantling costs are currently higher than for CRTs on a unit basis – reflecting the greater manual effort required. Recyclers are considering plans for future installation of automated techniques in order to reduce the unit costs. AXr Group[65] (one of the partners involved in the 'Reflated' (government supported) project on liquid crystal recycling at University of York[66]) are actively working on the reuse and recycling of flat screens. A company spokesperson claims to be building a prototype to deal with flat screens including backlight removal. These plans are at a very early stage of development and the technology and process remain confidential.

Production of FPDs involves the use of a variety of materials some of which are used in small but nonetheless significant quantities. The concern is that these are not being recovered at end of life. Illustrating the point, the European Commission's Green Week conference in June 2008[67], heard from Tom Graedel (Yale University) that FPDs use Europium in red phosphors as no other material has the required characteristics. The world production of Europium is just 0.34m^3 per year. The suggestion is that rather than mining the natural environment, we should be mining the wastes from our cities. If we do not then at some point we will severely limit our capacity to make certain products.

7.4 UK Trade Statistics

UK trade statistics contain the EU and non-EU trade figures which can be searched by 8-digit Comcode. The complexity is in interpreting which of the 8-digit codes covers which types of TVs and monitors. However, at the 4-digit level, most TV receiving equipment and video monitors are included (including CRT, LCD, Plasma etc.) as well as peripheral items such as tuner cards. The 4-digit description is:

[63] Sue Alston, "Options for Recycling Flat Panel Displays", Summary report based on thesis submitted to the University of Wales, Swansea. October 2005.

[64] (EDV, Elektronikschrott, Abfallwirtschaft 1993, pp. 231-241)

[65] www.axrgroup.com

[66] http://www.york.ac.uk/admin/presspr/pressreleases/recyclelcd.htm

[67] http://ec.europa.eu/environment/greenweek/conference_pres.html

- 8528:TELEVISION RECEIVERS, INCL. VIDEO MONITORS AND VIDEO PROJECTORS, WHETHER OR NOT INCORPORATING RADIO-BROADCAST RECEIVERS OR SOUND OR VIDEO RECORDING OR REPRODUCING APPARATUS

8-digit codes (e.g. 8528xxxx) provide further detail as sub-categories of the 4-digit code. The total imports and exports (both EU and non-EU) at this 4-digit level are shown for 2007 in Table 16 below.

Table 16 - Total Imports and Exports (tonnes) for Code 8528

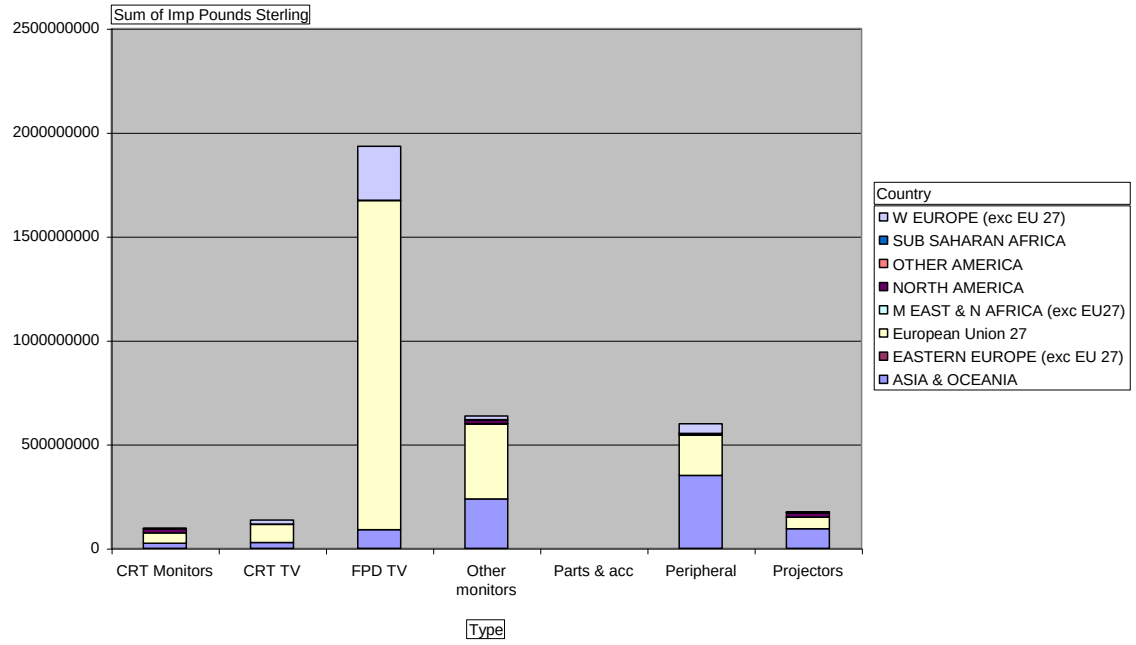
Comcode	Flow	Total Imports	Total Exports	Net Imports
8528	Total	292,109	55,213	236,896

These import/export figures do not distinguish between new goods and re-use goods. However, the ICER WEEE exports study (2004) estimated that at least 10,000 tonnes of computer monitors and 11,000 tonnes of TVs were exported as WEEE.

The main problem with seeking data on waste TV exports is that these items could be exported under a range of codes, some covering wastes, others new or reusable equipment, thus making it impossible to extract reliable data. This is a problem experienced by other countries as well as the UK[68].

Businesslink.gov.uk provides guidance on the classification of products to import/export codes, including guidance on the classifying of TV receiving equipment. On this basis, imports to the UK of code 8528 goods breaks down as shown in the Figure 7 below.

Figure 7 - Code 8528 Imports - value (£) of imports by type (2007)



The total world trade (both EU and non-EU trade) in TVs with the UK breaks down as follows (2007 data).

[68] For example, see "The Clearer Picture: Enforcement action in 2006 on exports of WEEE", VROM Inspectorate, The Netherlands, Eindhoven, 8 March 2007.

Table 17 - UK Import and Exports of TVs (2007) by TV Type

TV Type	Imports		Exports	
	£	Quantity (t)	£	Quantity (t)
Colour CRT TVs	134,185,965	16,014	63,868,358	5,590
LCD/Plasma TVs	1,933,355,370	189,231	396,544,200	25,414
B/W CRT TVs	1,764,359	57	1,720,666	1,229

It is clear from the above table that CRT TVs have been overtaken largely by Flat screen TVs in the market place.

7.5 Waste Exports

Information on the export of EOL display equipment is starting to become available from the Environment Agency through their analysis of data returns from Producer Compliance Schemes (PCSs) and Reg32 entrants, Approved Authorised Treatment Facilities (AATFs), and Approved Exporters (AE's). Such information includes 'Display Equipment' (Category 11). No further breakdown is provided (i.e. no information on the display types).

Currently, there appears to be inconsistency between data provided by exporters and data provided by the PCSs, which the Agency is investigating. For example, whilst the PCSs/Reg32 returns indicate that no display equipment was exported in the first six months of reporting, the AE's returns indicate that about 1,252 tonnes of display equipment was exported for recovery/recycling and about 157 tonnes of display equipment was exported for re-use[69]. Although these figures could change in the light of further investigations, they appear to be at odds with the ICER estimates.

With regard to data reporting, AATFs are required to provide data on the amounts they receive, treat, reuse as a whole appliance, and amounts going off-site to ATFs, AATFs, AE's, Reprocessors, and (from 2008) amounts sent to a reuse establishment. However, amounts sent off-site includes the amounts that have been treated. For example, for CRTs treated by the AATF, the amounts recorded as sent to AE's will include glass from the treated CRTs. Although this may be recorded as Category 11 display equipment, it is not in the form of display equipment. The current data for the first six months indicate that 7,647 tonnes of display equipment was exported. This appears closer to the ICER estimates albeit that this figure includes treated display equipment (e.g. CRT glass exported). Note: it is possible that the figures may be susceptible to double-counting errors (e.g. AATF tonnages sent to AE's also recorded by the AE's). Hence, this data should only be considered with caveats about their accuracy.

7.6 Waste Management Routes for Display Equipment

Following the introduction of the WEEE Regulations, and with it, the requirement for adequate collection facilities to be made available (e.g. at CA sites and Designated Collection Facilities (DCFs)), all EOL TVs are now collected, with very little 'slipping through the net' to landfill[70]. – mainly because a) the units collected are largely as predicted, and b) TVs are too big to fit in the household dustbin and are taken to CA/DCF sites Furthermore, there are currently only 2 major routes for these collected TVs – recycling and export.

The Environment Agency data returns provide a six-month 'snap shot' of the routes taken by display equipment at end-of-life. The following table shows the data received from the Agency[69] re-arranged to illustrate the proportions of collected display equipment that go to reuse, export, or treatment and recycling in the UK.

[69] Data obtained from the Environment Agency WIRS – telephone communication.

[70] Claire Snow, ICER – personal communication.

Table 18 – Percentage Display Equipments entering waste management disposal routes

	July-Dec 2007 (Tonnes)	**%**
Total collected:	38,760	100%
Reuse		
Exported for reuse:	158	
Reuse as whole appliances:	3,900	
Sent to reuse establishment:	N/A 2007	
Total reuse:	**4,058**	10%
Exported		
Total exported:	**7,647**	20%
less exported for reuse:	-158	
less exported for recycling:	-1,252	
Treated then exported:	**6,237**	16%
Treated and recycled in UK:	**27,055**	70%

Note: caution should be exercised in interpretation because the quarterly data returns are currently exhibiting wide variations.

8 Conclusions

For the past 50 years or more, the prevalent TV technology has been CRT. Even as recently as 2002, CRT accounted for 96% of UK sales. It is not surprising therefore that the life cycle issues associated with producing, using and handling CRTs at end-of-life are sufficiently known for reliable information to be available to inform the Defra evidence base.

The TV market though is dynamic. In the last five years new TV technologies, principally LCD and plasma, have overtaken CRT such that CRT sales are estimated to be just 19% of total sales in 2008. CRT market share will continue to fall.

Evidence also suggests that consumers have accepted the newer technologies and their advantages and as a result, are buying larger screens. Additionally, drivers such as the switch-off of the analogue TV signal are prompting consumers to consider changing their TV for a newer, digital ready model. This clearly defines a need for the developing Defra evidence base to capture LCD and plasma technologies. It is also worth noting that the private sector purchase of TVs is significantly higher than that for the public sector.

There is a higher intensity of televisions in the UK both in stock and usage terms. However, there seems to be little difference between the TV models entering the market with screen size projected to be similar and LCD technology dominant. Therefore, the technical analysis in the EuP will be valid in the UK scenario. Using the 2007 sustainable products consultation, this suggests that UK impacts of TVs per person could be as much as 4 times greater than Europe and could be set to increase to almost 5 times. However, with the updated data in the 2008 TV roadmap snapshot, the impact is approximately twice the EuP prediction.

Regarding product convergence, the energy consumed by converged products compared to the individual products changes on a case-by-case basis. Modelling suggests this varies between a 20% reduction to a 40% increase in the worst case. Convergence is likely to increase energy consumption if the products are not equipped with adequate power management features. With power management, savings can be realised simply because it reduces the number of products left on unnecessarily. At a practical level though, whether convergence will be realised (market perspective) or is in fact desirable (environmental perspective) is a moot point warranting further consideration and discussion. Some commentators see the concept failing on both counts. Policy may be better directed to achieving good performance from the individual products rather than chasing an unproven premise.

Broadly speaking the energy in-use aspects of the life cycle are well understood not only for TVs but also for peripherals such as video playing and recording equipment.

The production (supply chain) and end-of-life aspects of FPDs are not so well documented as the energy in use aspects. From our literature review and discussion with stakeholders, we show that:

- Although CRT manufacturing has become uncompetitive in Europe, TVs entering the UK, mainly LCD and PDP, are supplied mainly by the same traditional 7 leading brand manufacturers, mostly with final assembly in Central Europe, close to the Western European market. Locations are chosen by the stronger global businesses for their advantageous balance of skills, costs and transport infrastructure. Import duty rates for TVs and for the panels also affect this balance.

- UK import statistics show TV imports are dominated by Spain, Slovakia, 'Western Europe (excluding the EU27)', Hungary, Poland and the Czech Republic. Those from Asia and

Oceania as a whole typically constitute only 5-6%, with China leading among Asian importers.

- There is a recent trend back to vertical integration in 6 of these 7 leading brand companies as production of the flat panel Module (the sub-assembly of the Cell, predominantly from Asia, and the electronics) which is the main cost component in the TV, is also moving in some cases from Asia to Central Europe. The leading brand TV set manufacturers with final assembly in Europe are resisting the competition from (other) Asian panel manufacturers to introduce TVs to the UK, supplied from Asia, partly from their experience of adapting TV designs to the various EU country requirements.

- For the leading brand TV manufacturers there are 3 main forms of supply chain for FP TVs:
    - Internal Manufacture by Brand in Europe – brand makes or buys the FP module
    - Purchasing by Brand from Asian / Turkish ODM with EU Assembly – an ODM assembles in Europe for a brand owner, with kits prepared by the ODM in Asia
    - Internal Manufacture by Brand in Asia – brand company manufactures and supplies from Asia

  One company may use a combination of these for different products within the same brand.

- Manufacturers are sourcing glass and many Electrical and Electronic (EE) components from China and the Far East according to technology specialisms, quality and price. Some companies prepare kits for assembly in Europe.

- Specific data on the range and aggregated quantities of materials within the many sub-components in TVs and their sources is limited, typically to those significant as rare, hazardous or controlled to achieve environmental standards or legislation. Further research would be needed to establish the (potential) effects of Nitrogen Triflouride (GHG) emissions and of depleting rare materials, for example, the Indium, Europium and Copper, attributable to TV supply, especially if un-recovered.

- Life Cycle Assessments for flat panel TVs, with input from a sufficient range of suppliers, many in Asia, would be needed to attribute environmental impacts to the supply chain aspects in detail.

Regarding end-of-life:

- Environment Agency data suggests that 89,000 tonnes of end of life display equipment is collected per year of which 99.9% is CRT technology. Within this total, the fate of TVs is: 10% are reused, 20% are exported and 70% are recycled. NB: the UK WEEE data is still showing inconsistencies as implementation is still new.

- The vast majority of TVs presently arising at end of life are CRT. For these, tried and tested processes are applied to aid material recovery and compliance with WEEE Regulations.

- Because they have seen very few examples of FPDs arriving for recycling, recyclers say they have little experience of handling them although those they do handle are handled in compliance with the WEEE Regulations. A number of different recycling processes are under development, but there is currently no favoured BAT (Best Available Techniques) for treatment. It is noteworthy that in recognition of the dearth of information regarding end–of-life treatment for FPDs, WRAP announced a call for tenders in July for the express purpose of consolidating the published research.

- An issue here is that the implementation of new recycling processes requires investment and few recyclers are willing to invest until they are sure that a process is deemed compliant by regulators with the WEEE regulations. This suggests that dialogue between recyclers and policy makers would be helpful and that clear and agreed guidance is generated and made available as a result.

- FPD production involves the use of a variety of materials including some with resource depletion issues e.g. Indium, Europium, Copper, some of which are used in very small quantities. Because some of these materials are reportedly available in nature at very low concentrations, more attention should be paid to their recovery. Further examination of this point is required to inform policy of the scale and scope of the issue as affects current and potential future TV technology. It would be an opportunity lost if a new energy efficient technology was developed if its manufacture was dependent on a rare material that for whatever reason was not recovered at end of life.

- Anecdotal evidence says that a significant quantity of end of life TVs and ICT equipment is shipped from various points around the world to Africa and China amongst other destinations. Such stories rarely include details of product types and shipment source however, so attributing this to the UK in terms of volumes is difficult. Hard evidence is even less easy to locate although in this regard Defra should note the EU's Impel network study[71], recently published, saying that over 15% of the waste shipments inspected across Europe were illegal. The report says that the inspections of shipments from England and Wales revealed no violations, whilst 50% of the shipments from Scotland were found to be in violation of regulations. It should be noted though that the inspection sample size was very small in both instances (4 and 12 respectively). Impel calls for stronger political will and more resources to tackle the problem. Responding to the work, the Commission is considering the role for specific, legally binding rules for inspections.

[71] http://ec.europa.eu/environment/impel/reports.htm

Annex A: Study Consultation Contacts

Axion Recycling, Keith Freegard (WEEE plastics recycling expert)

Axr Group, Peter Murphy (Technical Director)

Defra, Rocky Harris (Trade data enquiry)

EMR Ltd., Chris Caffrey (WEEE Manager)

Environcom Ltd, Jeff Weeks (Business/Technical Manager)

Environment Agency, Jane Skinner (WIRS Manager)

GER, Bob Shepherd (CRT processor)

ICER, Claire Snow (WEEE exports)

Intellect, Consumer Electronics Energy Efficiency Group, George Fullam (UK TV market and supply chain)

Meko, Bob Raikes (UK supply chain information for LCD TVs)

NISP, Peter Hart (CRT reprocessing in social enterprises)

Oakdene Hollins, David Parker (Remanufacturing expert)

Shore Recycling, Malcolm Todd (Processor dealing with EOL TV's)

Sims Group, Gary Morgan (Business Development Manager)

TV manufacturers (The available representatives from some of the top 7 TV brands were consulted for industry-representative views on the supply chain)

VALPAK, Adrian Hawkes (WEEE compliance scheme)

Wincanton, Simon Hill (AATF dealing with end of life (EOL) TVs)

WRAP (Waste and Resources Action Programme), Gerrard Fisher (Products Sector Manager providing advice on end of life (EOL) issues)

Annex B: Interview Guidelines

The following questions were made available to the TV brand company representatives to prime the discussion about supply chain and associated material issues and sources.

1) From which country/region(s) are the LCD / PDP / CRT TVs sold in the UK under your brand…

a …supplied as branded TVs
b …assembled / manufactured
c …major parts supplied

2) For LCD / PDP / CRT TVs, what are the major supply chain elements for TVs placed on the UK retail market and their country/region locations
e.g. i. component & material sources (mainly China, Japan, Korea ?)
ii. major parts manufacture/supply (e.g. China)
iii. assembly (e.g. Spain)
(Please comment on the routes illustrated in the draft supply chain schematic – are they representative of the supply chain for your TVs?)

3) Please comment on the reasons for the location of these supply chain elements and whether the pattern is changing.

4) To identify some of the significant environmental impacts of materials
a which components are associated with environmental impacts and where are they sourced from ?
b which materials and substances contribute to significant environmental impacts e.g. pollution in material sourcing/manufacturing/end-of-life?
c. are there publicly available references to materials used and/or environmental information e.g. a report, perhaps with a summary of major material constituents or Life Cycle Assessment results?

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Nobel House
17 Smith Square
LONDON SW1P 3 JR

www.defra.gov.uk