

Analyzing End of Life LCD TV WEEE Flows in Europe

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Abstract

Since the introduction of LCD TVs in 2005, consumers exchanged their bulky CRT television with a new set of flatter and lighter LCD television. As a result the migration to flat TVs has been steadily progressing. Considering the upcoming increase of LCD TVs in the return stream, there is a strong need to quantify the amounts generated as waste. In order to do this, the study utilizes a Sales-Stock-Lifespan model to estimate future flows of LCD TVs across twenty European countries from 2005 to 2016. Quantification of patterns in the waste stream can help designers and decision makers to anticipate on design consequences in collection and treatment before posing new design changes.

Keywords:

waste electrical and electronic equipment, LCD TV, sales-stock-lifespan model, end of life

1 INTRODUCTION

For 2012, the predicted global sales for Liquid Crystal Display (LCD) TVs were 203 million units which proved to be the most popular among the other type of TV technologies sold worldwide. Followed by Cathode Ray Tubes (CRT) TVs (16 million units), Plasma Display Panel (PDP) TVs (13 million units), Rear Projection (RP) TVs (50 thousand units) and Organic Light Emitting Diode (OLED) TVs 1, 2. Although the overall LCD TV market has recently declined in Europe, there is still an increasing LCD TV waste stream on the horizon. In Europe, waste LCD displays are subject to the WEEE Directive (2002/96/EC), which regulates the reuse, recycling or recovery of waste electronic and electrical equipment (WEEE). The treatment of WEEE must ensure that all hazardous materials are properly contained and diverted from landfill. For CRT TVs, recycling technologies have been established and the volumes in return stream is decreasing, but the collection and treatment of LCD TVs is a new challenge. Considering above discussed consequences, there is a need for estimating End of Life LCD TV generation in Europe. Knowing the availability of sufficient volumes of LCD TV's in the waste stream in a certain geographical region will help decision makers and designers to realize if collection, transport, processing as well as more long term redesign efforts are worthwhile activities.

2 MULTIVARIATE ANALYSIS: SALES-STOCK-LIFESPAN MODEL

United Nations University (UNU) has developed a statistical model that estimates the quantity of EEE put on the market and the quantity of WEEE generated, based on data of sales, stock and lifespan profiles. This model has been already used for quantifying WEEE in the

Netherlands 3, Italy 4 and Belgium 5. The UNU model is also applied in this study specifically for LCD TVs. Detailed explanation of this model can be found in 6.

3 PUT ON MARKET: EEE

Based on data from the national statistics as well as the registrations of equipment put on the market by producers and sales data from reports by the European Information Technology Observatory (EITO) 7, a time sequence is made of the quantities of LCD TV put on the market that runs from 2005 to 2016 for major European countries. At the same time the quantities of LCD TV put on the market for few emerging countries collected for a better understanding of current state of European Union. The quantities of LCD TVs are expressed in pieces per 100 inhabitants, as shown in Figure 1.

In the majority of countries, LCD TV sales followed a fairly similar pattern over the years. In the first year (2006) the sales started by 4 to 6 pieces per hundred person and in the last five years the sales remain at between 10 and 12 per hundred person. The general trend though for France, Italy, Denmark and Spain was a decline in the number of pieces sold over the last five years, with all at around 12 pieces per hundred person in 2010. In comparison, it is estimated that both Norway and the Netherlands will experience a downward trend in the number of LCD TVs by 2015. Remarkably, it can be seen that the total sales were far higher in Britain than in other Western European countries throughout the whole time frame. This also matches with the EITO reports data. The reason for the 'anomaly' for the UK is not understood. However, it is obvious from the figure that the majority of EU countries sales data fall into the same "Spaghetti bundle".

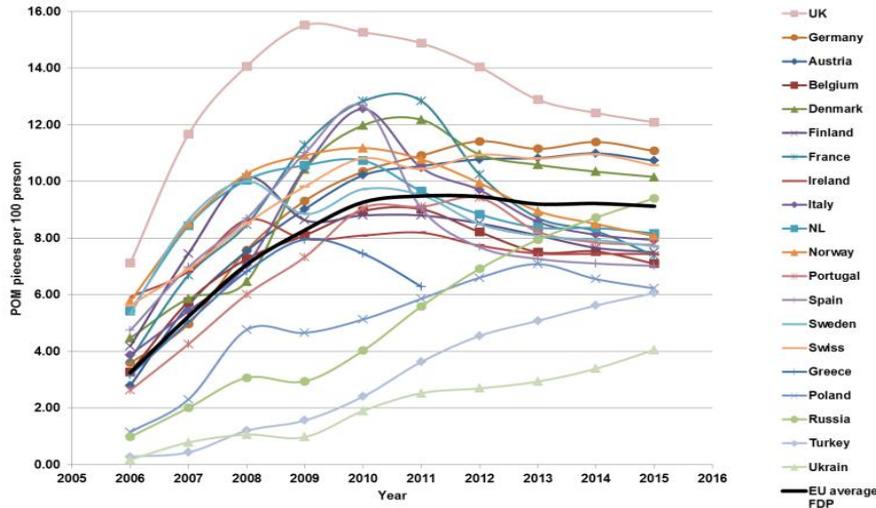


Fig. 1: LCD TV put on market total EU, incl prognoses

In contrast, Ukraine, Turkey, Russia and Poland all with much lower income levels, experienced an upward trend, starting the reporting period at just over 0, and finishing at just under 4 to 10 pieces per hundred person. In Belgium, Portugal, Finland, Sweden and Ireland the amount of sold LCD decreased gradually after 2008. Greece continued to decrease as well but more steeply to 6 pieces per 100 person in 2011.

It is important to note there are some external factors that affect the CRT replacement market penetration. One of these external factors is the income level. For electronics purchases in total it is assumed that countries with higher income level purchase more LCD TVs, but the fact is that people buy LCD TV's anyway regardless of their income. The sales trend in Brazil, Ukraine, Turkey and Russia shows clearly that also in low income countries LCD TVs increasingly start to replace CRTs. Also from the China country study [9] it is known that TV's are among the first products to be bought by lower income groups. Therefore the income level is not a strong parameter for prognosing the penetration of LCD TV into the market. Another two parameters to look at are population size and number of households. The result of our study shows that population and number of households are also not very strong parameters that could affect the number of LCD TVs sold. In another word, larger population size does not necessary mean more TVs sold. With only a weak socio-economic correlation due to complex anthropological effects, high uncertainty in long-term patterns, using external factors to estimate the amount of WEEE generated, which is the least explored method so far is not recommended for advanced modelling techniques.

4 LIFESPAN

LCD TVs that are put on the market will become waste after some time. The lifespan of LCD TV can be different per country. However, for this study the 'lifespan' is obtained from the average lifespan of LCD TV sold in the Netherlands in 2012. That is mainly because there is not enough accurate information available to produce more detailed lifespan profiles for other EU countries. Therefore, it is assumed that the parameters from the Netherlands are representative for other countries in the study. The lifespan of TV's is however found to be very similar in the country studies done in Italy, Belgium and France [3, 5]. The average weight per pieces in years and applied median lifespan in years are presented in Table 1. As we move from 2006 to 2012 the expected lifespan and weights of LCD TV are decreasing. It is interestingly to note that although screen sizes are increasing, the average weight per TV is not due to thinner panels. This trend is expected to continue for anticipated future rise in OLED sales as well.

Table 1: LCD TV lifespan and weight in years

Sales year	Expected lifespan (median, in years)	Average POM product weight (in kg/pc)
2006	9.7	14.5
2007	9.6	14.5
2008	9.5	14.3
2009	9.4	14.8
2010	9.2	14.7
2011	9.1	14.0
2012	9.0	13.5

5 STOCK

The stock of equipment that is present in households is calculated based on the lifespan profiles and the quantities of EEE put on the market. In 2012, the total stock in households and companies is calculated together at maximum 10.8 kg per inhabitant. This is a total of approximately 80 pieces per hundred inhabitant. However, in order to make better and more detailed calculations possible in the future, it is recommended to hold a detailed survey among consumers in order to gain more insight into the lifespan of the stock.

Figure 2 shows the number of LCD TVs in stock per hundred persons (incl. 'hibernated' products that are already 'out of use' but not yet physically removed from the household). As expected, the number of LCD TVs present in both households and businesses increased. The black line shows the average amount of LCD TVs in stock per hundred person. Basically, it shows dramatic increases in the number of LCD TVs from less than 10 pieces per hundred person in stock in 2006 to 60 pieces per hundred person in stock in 2015.

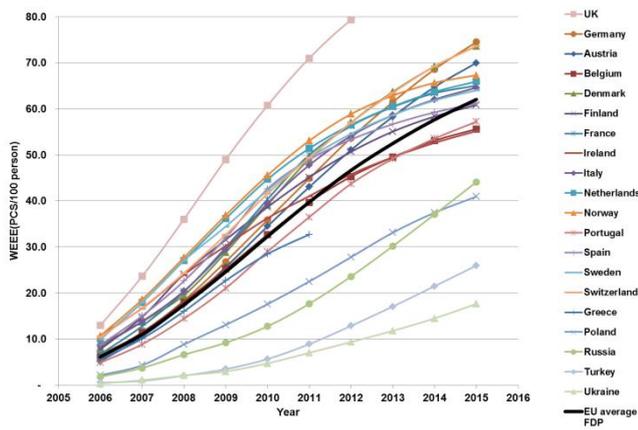


Fig. 2: Stock (pieces per hundred person)

Although the LCD TV sales and stock levels have upward trends over the past ten years, but it is predicted that the market will reach a saturation level around 2013. At the point of saturation, further growth can only be achieved through product improvements. This phenomenon is easily explained in Figure 3 for the transfer from bulky CRT TVs to FDP TVs. The graph shows the evolution of total stock of TV compared with the number of households between 1990 and 2015. As number of households increase the total TV stock increase as well, but at a certain point (in 2005) the market faced a saturation level and with introducing LCD TV to the market and shifting from analog to digital (CRT to LCD) the market moves to the next level.

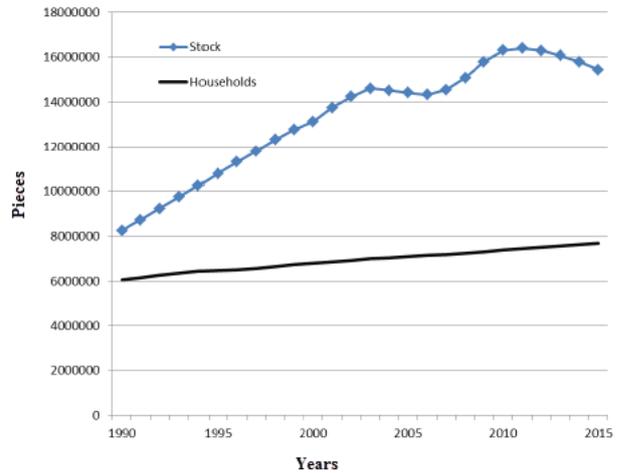


Fig. 3: Market is moving to another level

As we move towards 2015 there is also the possibility that the market face another saturation level as shown in Figure 3. To make the market to move to next level another technology shift is required, and that is where moving from CFL to LED as TV backlights can play a role.

6 LCD AND CRT WASTE GENERATION

With an increase in number of LCD TVs sold between 2006 and 2010 the total amount of waste is rapidly increasing. Due to the lifecycle of around 9.5 years, the total market input only becomes substantial around 10 years later in the WEEE return stream. See also the scale for put on market amounts in Figure 1 for comparison.

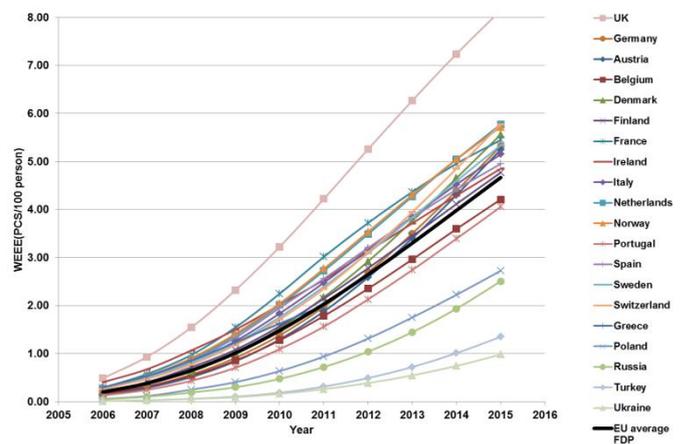


Fig. 4: WEEE (pieces per hundred person)

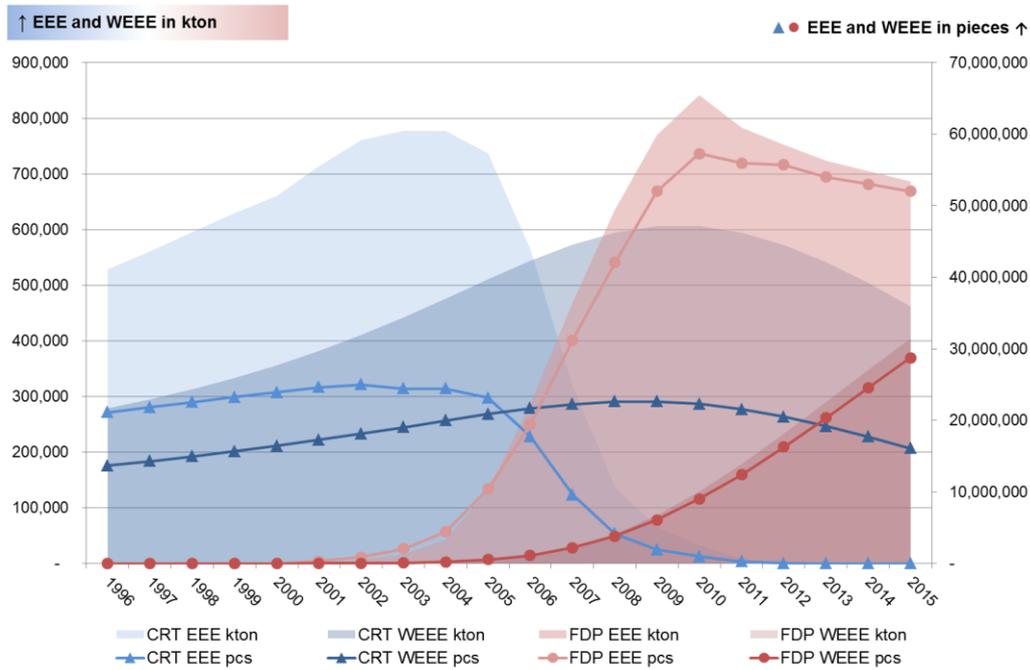


Fig. 5: CRT replacement and expected WEEE

Figure 5 presents the CRT replacement and the amount of waste generated for the whole EU market between 1996 and 2015, both in kiloton (kton) and pieces. Around the year 1996, CRT sales were at a level of 20 million units, and increased slightly from 1996 to 2005. From 2006 sales fell steeply to less than 10 million and continues to decline to about zero pieces in 2011. Simultaneously, the number of CRT in the waste stream rose gradually from 15 million pieces in 1996 to 20 million pieces in 2009 and declined gradually after 2009. Given the technology shift and introduction of flat panel displays, flat panel display sales increased dramatically from 10 million pieces in 2005 to 55 million pieces in 2012. It is predicted that there will be a gradual decline in sales after 2012. The number of FPD TV's sold by 2015 will be equivalent to 700 to 800 thousands ktons. As the number of flat panel display sales is rapidly increasing, the number of FPD pieces in waste stream is increasing as well. It is estimated that 30 million of FPD will reach to their end of life by 2015 which is equivalent to 400,000 ktons. it is obvious that the market will continue to saturate with increasing sales of LCD, before they enter the return stream in substantial volumes.

7 LCD TV END OF LIFE SCENARIOS

To find out where LCD TVs end up after disposal an extensive WEEE market survey conducted in 2010 in the Netherlands by looking at sales, stocks, lifespans, waste generation and from there at reported and previously not reported recycling, as well as legal and illegal export flows and waste bin sorting analyses. The result of the survey was a mass balance for the flow of all EEE and included TV's as well 3. Based on the results derived

from the survey; it is calculated that 1.74 kilogram per inhabitant of TV's was put on the market in 2010 in the Netherlands.

Table 2: The Dutch TV Waste flow 2010 3

2010 in kg/inh	TV
TV POM 2010	1.74
Waste TV + used TV Generated	1.85
WEEE + used EEE / EEE ratio	106%
Export used TV	0.49
Export used TV HH whole appliances	0.49
Export used TV B2B incl. refurbishing	0.00
Waste TV Generated 2010 NL	1.36
WEEE / EEE ratio (excl. export)	78%
Documented + export used TV	1.78
Households	
Wecycle/ICT~Milieu	1.25
Complementary	0.00
Businesses	
Complementary	0.04
Compl. recycling B2B + HH	0.05
Waste/incineration	0.00
Not (yet) documented	0.1 – 0.1
Potentially identifiable min/max	0.0 – 0.0
Unidentifiable, min/max	0.0 – 0.1

Export of used TV is documented as 0.49 kg/inhabitant, (28% of Put on Market). Export of used TV reduces the WEEE potential that can be collected and treated in the

Netherlands to 1.36 kg/inh. The ratio of TV waste generated in the Netherlands over (same year) POM is 78% in weight. Of this, the appointed producer compliance schemes Wecycle and ICT-Milieu collected and treated 1.25 kg/inh (71% of POM). The WEEE generated model calculates the amount of WEEE plus used TV generated in the Netherlands at 1.85 kg/inh. The ratio of WEEE plus used TV versus the same year POM is 106% in weight, mainly due to many much heavier CRTs in the return stream. Parallel to this, the total complementary recycling stream is 0.05 kg/inh (2.8% of same year POM). No TV's are reported to end up in the waste bin due to size constraints and ending up in incineration or landfill. A more detailed quantification of TV flows in the WEEE chain is presented in table 2. Similar information as shown here for the Netherlands is rarely available for other EU countries. However, it is expected that also in other countries the consumer and trading behavior will be very similar.

8 CONCLUSIONS

1. The quantity of LCD TVs put on the market is minimum 0.405 kg per inhabitant and maximum 1.89 kg per inhabitant in 2012.
2. In 2012, the total LCD TV stock in households and companies is calculated together at minimum 1.35kg and maximum 10.8 kg per inhabitant. This is a total of approximately 10 to 80 pieces per hundred inhabitants.
3. Average LCD TV lifespan is around 10 years and is steadily declining.
4. Due to the lifespan of around 10 years, the total market output as waste only becomes substantial around 10 years later in the WEEE return stream
5. Due to CRT replacement the LCD sales has drastically increase from 2 to 4 pieces per hundred person to 8 to 10 pieces from 2006 to 2010, but the amount remains constant between 8 to 10 pieces sold per hundred for the last five years for EU15.

9 RECOMMENDATIONS

1. From a research point of view it is advised to repeat the monitoring and validation of the sales data in cooperation with the compliance schemes and national statistics per country involved in the study.
2. This study was mainly dealing with LCD TVs. Obviously more data are required to estimate different types of TV's in the waste stream.

3. Given the fact that the number of households, TV stock and residence time could be varied from country to country, therefore it is advised to include future information from consumer surveys in more countries for more detailed outcomes.
4. A large part of the complementary flow is managed by the national recyclers. Therefore, it is advised to get more complete reporting on return streams outside the contracted recycling from recyclers. Especially because these data could vary from country to country.

10 ACKNOWLEDGMENT

The research leading to these results has received funding from the ENIAC Joint Undertaking under grant agreement nr. 296127.

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