The LCA of an existing TV and our proposed Display solution to lower the environmental impact of this service

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Contents

Included Tables

Included Figures

Introduction

The aim of this project was to see the environmental impact of TVs, by doing a streamlined LCA of a TV, then by taking the information, to reduce the impact by coming up with newer solutions which have a big impact on the areas that have the highest energy consumption. By reducing the areas which have the biggest impact the aim of the project would be to significantly reduce the CED of the product over its life time. By extending the lifetime of the product, this means that the products CED per year will also be reduced as the manufacturing section will be more distributed across more years making the products manufacturing having a less effect on the environment.

The following are background of methods used in the report.

Streamline LCA

The LCA of a product looks at the environmental impact of the product throughout its life time. A extensive LCA takes a lot of time to do, but gives a great insight into the impact each element of the product has on the different environmental impact. However often and extensive LCA is not practical to do due to its complexity and the amount of time/resources consumed.

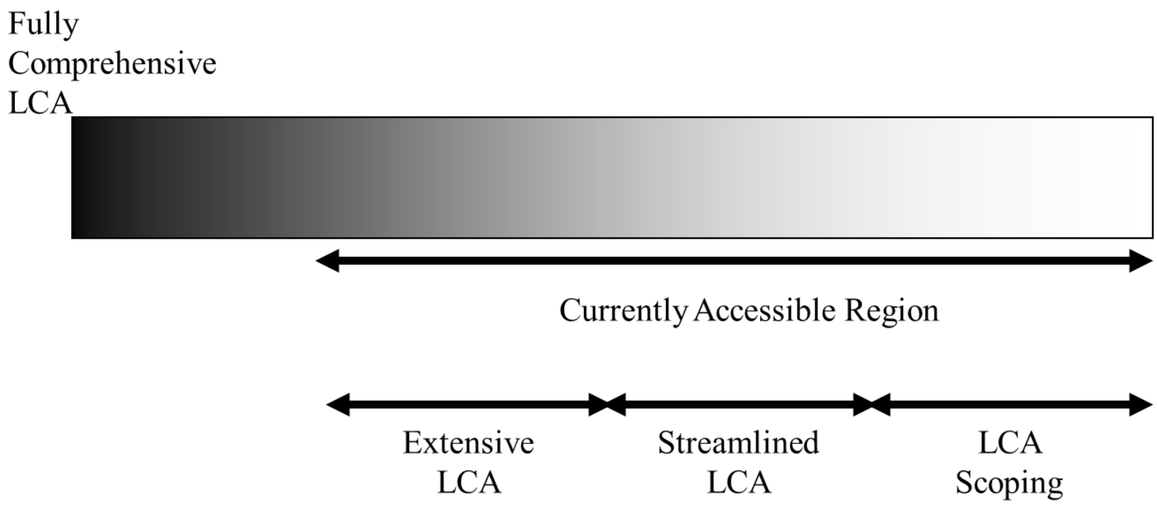

Figure 1: LCA spectrum

The streamlined LCA looks at the energy used in each of the stages of the life cycle and uses this to estimate the environmental impact on the environment. It works by calculating the energy in the products stages and by using matrixes based on different (easily accessible) parameters to calculate (to a close approximation) what the outcome from a full LCA would be. Figure 2 shows the correlation between the CED of a product and the different environmental impacts by different studies. It is clear from the graphs that there is a strong correlation and so shows that it is a good approximation.

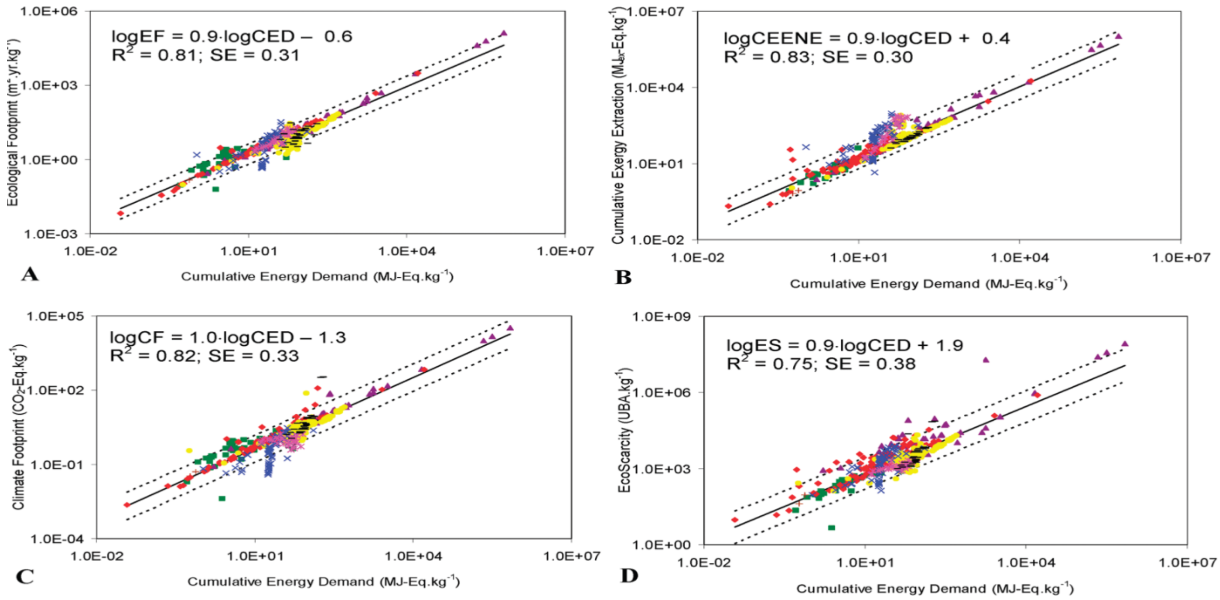

Figure 2: Correlation between CED and different environmental impacts [1]

Product service system (PSS)

This is a new system whereby rather than selling the product to a customer, the service that the product will provide will be sold. There are many examples of this in action from different companies, but since the product is always owned by the manufacturer:

- Product is designed to last longer
- Product is serviced and taken back by the manufacturer making it more efficient
- Diagnostics can be sent back to let the manufacturer know when it needs a service
- The best product for the job rather than the one that provides the most profit will be chosen

This concept will be used as it adds lifetime to the product and also improves the number of products returned for remanufacturing and/or recycling when the life of the product is over. This means that the manufacturer will use the materials in the products in the most effective way.

How materials, energy and waste present issues for TVs

There are many materials involved in the making of a TV. Whether it is a CRT or an LCD/LED/OLED, each of these has their own speciality materials that make the display of images possible. Each of these options has different effects on the CED of the product. Each use different amounts of power/have different materials (and energy costs associated with extracting these materials) and need to be recycled differently.

Along with the high energy required to extract the raw materials and also to manufacture TVs, their energy costs associated with their use phase is still quite high. Although the introduction of LCD/LED TVs has dramatically reduced the power requirements, due to the larger TV sizes, the power consumption saved by the new technology is not being used to save power and in fact the power consumption of TVs has gone up. [2]

Many people, when finished with a TV do not dispose of it properly, although the introduction of WEEE and the fact those suppliers have to take back the products when selling a new one has reduced the amount of TVs going into waste. Whether it is recycled or dumped, there are still many aspects of TVs that recycling plants do not see worth recycling due to the cost of recycling the material being more than what it is worth. This is due to a combination of the product not being easily disassembled and parts are not easy to get to or there are not enough of the products being returned to set up the infrastructure to process the products for recycling.

Baseline assessment of the products environmental impact

The baseline calculations for the existing TV was taken from the **Bang and Olufsen LX5500 28" Television** (Figure 3) because the bill of materials was accessible online.

Figure 3: Baseline TV [3]

Appendix A: Baseline Calculations (Bang and Olufsen LX5500 28" Television) shows the calculations for getting the baseline figures. These figures show that there is a manufacturing energy cost of 2530MJ and a per year energy cost of 3573MJ. Over a period of 5 years, this accounts for a CED of 19895MJ (3975MJ per year). It also gives the CED graph as shown in Figure 4.

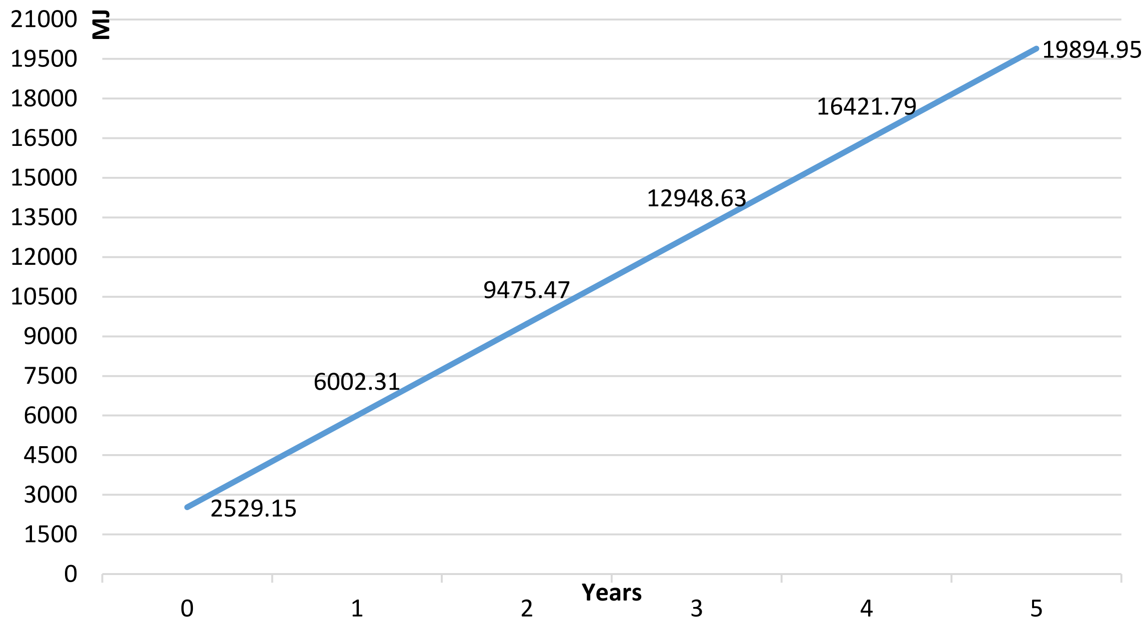

Figure 4: CED of baseline TV

It is clear from the graph that it uses a large amount of energy in both the manufacturing and use phases. The fact that the product cannot be remanufactured also leads to a low enough life expectancy. By addressing these factors, the CED of the product can be reduced leading to both a more sustainable product and a more efficient product.

Functional unit and system boundary

The functional unit of a product is used to compare the CED of the product based on the amount of use that will be gotten out of it. A product may have a really low CED but if it is only going to be used once, relatively it may be a lot higher or lower than another product for the same function. The functional unit is used to compare like with like so that when comparing, the results are more real to the amount of use they will get. The functional unit decided for this project was "Display facility per year". In this it was assumed that the TV would be active for 6 hours per day. These were decided as it describes both the older product and the new product.

It is also important to define a system boundary so that the LCA of the products can be repeatable and it is clear what is and isn't included. It is also used when comparing results between the LCAs. It is clear when someone is comparing the results that this one is lower because this was left out and that the amount of impact from leaving these out can be seen.

The system boundary for this project included the resources, manufacturing, use phase, remanufacturing and end of life phases. The system boundary doesn't include the support services, where the content is coming from and the transport/delivery associated with the product.

What approach was taken to improve the sustainability of the product?

The improvements made to the existing products include:

- ✓ Reducing the size of the product – less materials
- ✓ Reducing the power consumption
- ✓ Modular design for ease of remanufacturing and recycling
- ✓ Add sensors to detect the presence of people to:
    - Reduce unnecessary 'on time' – power saving
    - Extend the bulb life
- ✓ Change the bulb to be a high power LED
    - Longer lifetime
    - Lower power
- ✓ Sell as a Product-service system
- ✓ Diagnostics/Performance information to be sent back to manufacturer to ensure product is preforming at is most efficient for the customers usage
- ✓ Correct take-back procedures would reduce the amount of waste
- ✓ Make the product controllable via gestures/phone to reduce the electronics involved in the product by removing the remote from the equation.

In order to analyse the new system, an apple TV was taken as the basis of the network portion of the system and a Sony projector was taken to get an idea on the amount of materials and energy consumption that the new system would use. The difference taken was that the new product would be an LED instead of the 250W halogen bulb to significantly reduce the amount of power during the use phase and that the products bulb would last significantly longer to make sure that the CED per functional could be as low as possible.

Why should this approach improve the sustainability rating of the product/service?

By taking these steps, it was hoped that both the CED would be reduced and also the lifetime would be extended. By achieving this, the effective CED per year should be reduced and so the sustainability rating can be improved. Although a streamlined LCA was carried out on the baseline and new products (which means that not every aspect was not taken into account for each aspect on how the products affect the environment), the idea is that if there is a major decrease in the CED per functional unit, even though the ratio may not be accurate, it would show that there is a decrease in the environmental impact between the products.

By reducing materials and reusing them after the products life is up, the sustainability of the product will improve and the extracted materials will be used more efficiently making the product less prone to supply limits and increases in the cost due to large demands in supplies in the future.

A quantitative assessment of the new product/service

The calculations in Appendix B: New service calculations, shows the calculations for the CED for the new projector system. By incorporating the changes, the manufacturing stage's power consumption has reduced to (a mean of) 535MJ and the use phase is reduced to 649MJ. This is a dramatic decrease in the CED of the product for the same facility of the product.

By redesigning the product, the reduction seen in the calculations and in Figure 5 show that the newer product uses less energy over its lifetime and so, through studies, would imply that its carbon emissions and other environmental impacts are much less in the newer product over its lifetime.

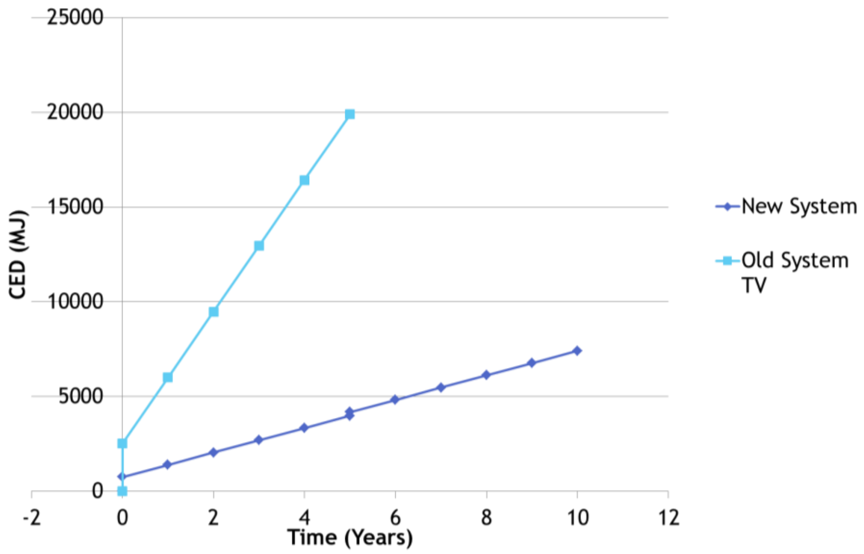

Figure 5: Comparison of CED between the old product and the new PSS

What challenges or barriers does the new product/service face?

The barriers that may come into play with the new service would include:

- Many people are already paying (monthly) for TV content and the increase in cost may be seen as extra cost and people may not see the benefits of the new service
- People may not like the idea of not being able to own the product as a TV is something that people like to own – even though when they came out first, leasing TVs was the norm so it may be accepted more than imagined
- If it was to be setup, people may not like the idea of a projector TV rather than a 'normal' TV screen
- The setup energy impact would be large, but over the 10 years of the product and as products get remanufactured, the energy impact of the business would become more efficient overall
- The initial investment into producing this product may be too large for businesses to invest in if they don't think consumers will follow the products
- With TVs getting higher and higher resolutions, (latest being 4k2k) the complexity of projectors would increase in order to keep up with the current TVs however, since it is modular – it would be easier to upgrade to a higher resolution
- A correct business model for PSS would have to be implemented in order for it to be cost effective for the business while not turning customers away from the products.

A lot of these barriers are mainly due to the changes in people's attitudes rather than the actual feasibility of the product design since the product is essentially the two modules given in the fact that it can currently be done by connecting an apple TV to a projector so it is not impossible to do although the more modular design that connects them together would be something to integrate but shouldn't be a problem. By convincing people that it has a much lower impact on the environment and that they can save money and use less power along.

Conclusion

In conclusion, the streamlined LCA of a product can give a good indication of the scale of the environmental impact of a product without a large amount of time being used to achieve the more accurate LCA. In this project, by using this version of the LCA, the baseline (original) TV's CED was calculated. After this, by reducing the areas of biggest impact and analysing the way in which the new system will operate, the amount of energy used in production and use phases along with the ability to remanufacture and dispose/recycle the product properly, a new product was designed to combat these areas.

Product-service systems will allow the product to be able to be used by the consumer while it doesn't pass ownership, as a result, the product should be kept up to date, well serviced and any issues can be solved by the manufacturer. This means that it should be more energy efficient, upgrades and remanufacturing will ensure that it lasts longer than previous products. With the correct take-back/recycling/remanufacturing procedures, it will generate less waste than the older methods where there was little recycling of products.

It is clear from the results that the newer, redesigned product leads to a large improvement (decrease) to the CED. By replacing the products with the new PSS which includes all the new features to reduce the manufacturing and use phases of its life, a much lower CED has been achieved. The main issues with the new PSS is convincing people that it is a much better way to go and that by doing this they will both reduce the environmental impact of the product over its lifetime and also save money in the process.

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Appendices

The calculations below are based off the charts from the ET4407 blog [4], for the energy costs of the different materials and manufacturing of the products. The amount of materials was taken from the listed references in the table caption.

Appendix A: Baseline Calculations (Bang and Olufsen LX5500 28" Television)

Baseline Manufacturing

Table 1: Materials, their weight and their energy cost for baseline calculations [5]

Material	Weight (kg)	Components	Energy Cost (MJ)
Glass	24.55	Picture tube, contrast screen	368.25-736.50
Iron (Fe)	2.58	Picture tube, contrast screen, speakers	51.60-64.50
Copper (Cu)	0.92	Picture tube, electronics	55.20-138.00
Plastic	13.00	Casing, rear cover, speakers	975.00-1495.0
Magnets	0.53	Speakers	10.6-13.25
Aluminum	0.33	Edging	62.7-75.9
Lead	0.12	Electronics	3.60-6.00
Total	**42.03**	**N/A**	**2529.15**

Baseline Use Phase

Table 2 : Baseline calculations use phase [5]

Use Phase	(W)	% Time	Power per yr (MJ)
Standby	3	75	622.31
On power	165	25	2850.85
Total			**3473.16**

CED per functional unit

$$\frac{Manufacturing + Lifetime * Power\ usage}{Lifetime}$$

$$= \frac{2529 + 5 * 3473}{5} = 3975 MJ/year$$

Appendix B: New service calculations

New product Manufacturing

Table 3: Materials for Apple TV and their weights and energy costs [6]

	g	Min (MJ)	Max (MJ)
Aluminium	90	17.1	20.7
Plastic	109	8.175	12.535
Steel	14	0.28	0.35
Total	**213**	**25.56**	**33.59**

Table 4: Manufacturing energy for Apple TV [6]

Manufacturing	
187.2	-Wafer manufacturing
5.086441	- PCB manufacturing
130	- Board assembly
2.5	- Final assembly
324.7864	**- Total manufacturing**

Table 5: Materials for Projector and their weights and energy costs [7]

	g	Min (MJ)	Max (MJ)
Plastic	800	60	92
Copper	200	12	30
Silicon	15	21	61.5
Aluminium	600	6	24
Glass	150	2.25	4.5
Steel	20	0.4	0.5
Iron	800	16	20
		117.658	**232.508**

Table 6: Manufacturing energy cost for Sony projector [8]

Manufacturing	
74.88	-Wafer manufacturing
5.086441	- PCB manufacturing
130	- Board Level assembly
1	- Final level assembly
210.9664	**- Total manufacturing**

New Product Use Phase

Table 7: New Product power usage

Use Phase	(W)	% Time	Power per yr (MJ)
Standby	0.42	75	10
On power - local	80.21	12.5	316
On power - stream	82	12.5	323
Total			649

CED per functional unit

$$\frac{Manufacturing + Lifetime * Power\ usage + Remanufacturing}{Lifetime}$$

$$= \frac{2529 + 10 * 649 + 200}{10} = 741 MJ/year$$