Lifecycle Project: LG 50LB5800

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Abstract

This project investigates the lifecycle of an LG 50LB5800 Smart TV from 2014, examining its production, use, and disposal. Using FreeCAD, an open-source CAD software, a detailed 3D model of the television was created and 3D printed at 15% scale. The production inquiry reveals that this specific model was assembled at LG's Mława plant in Poland, with key components like tin and gold sourced from Polish suppliers Fenix Metals and KGHM Polska Miedź. The research explores ethical concerns around conflict minerals in TV manufacturing and LG's policies to address these issues. A custom Google Maps visualization tracks the product's journey from raw material extraction to final disposal. The television's 10-year lifespan aligns with industry averages, though its disposal highlights ongoing challenges in electronics recycling, with Spain currently recycling only 35% of e-waste compared to the EU's 50% target for 2025. The project concludes by examining the environmental impact of e-waste and the need for manufacturers to take greater responsibility for product end-of-life management.

Contents

1. Criterion A: 3D Model

For my Digital Societies Lifecycle Project, I decided to research the lifecycle of an LG 50LB5800 TV. I have one of these at home, so it is convenient to measure and model. Since I found it being thrown away, and it currently doesn't work, I'm free to open it up and see inside if I want to.

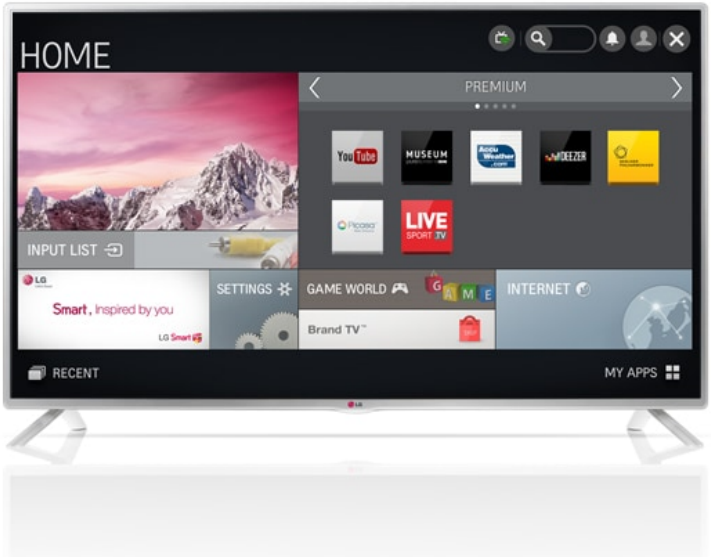

Figure 1: *50LB5800 LG Smart TV (LG Smart TV With IPS Panel — LG UAE).*

I decided to model the TV using CAD software, as I had previous experience using Fusion 360 and thought it was the most appropriate choice for this project. However, I had issues with licensing and downloading Fusion 360, so I decided to try out FreeCAD. FreeCAD is an open-source parametric 3D modeling software (j.). It has a variety of online resources, like tutorials and documentation, so I was able to learn it quickly enough for this project.

I started off the model by making a 2D sketch, and making a rectangle. This would be the base frame of the television. I then measured the frame of the television using a metre stick, to ensure the design was of a one-to-one scale. After the frame was done, I sketched the TV screen. This was more challenging as the only measurement I had was the diagonal length of the screen being 50 inches, however I was able to make an accurate sketch using constraints.

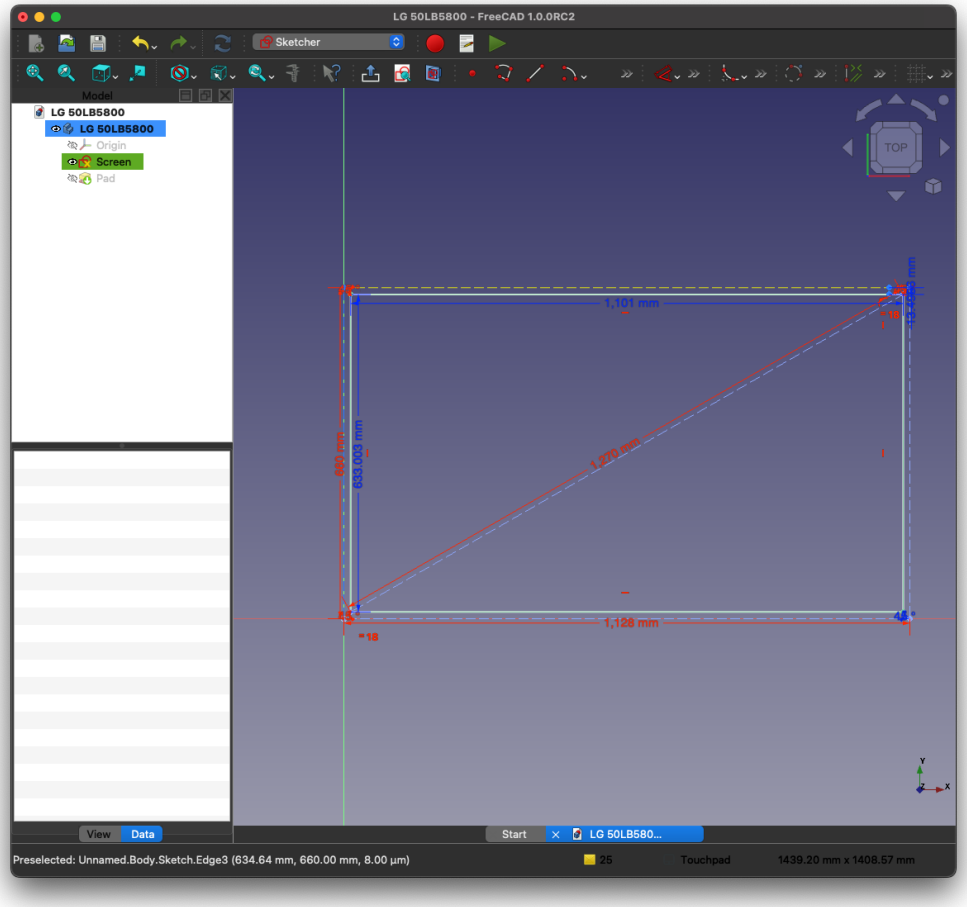

Figure 2: *Sketching the TV screen in FreeCAD.*

Then I extruded, or in FreeCAD terms "padded", the frame. I had to measure the thickness of the TV to make it to scale.

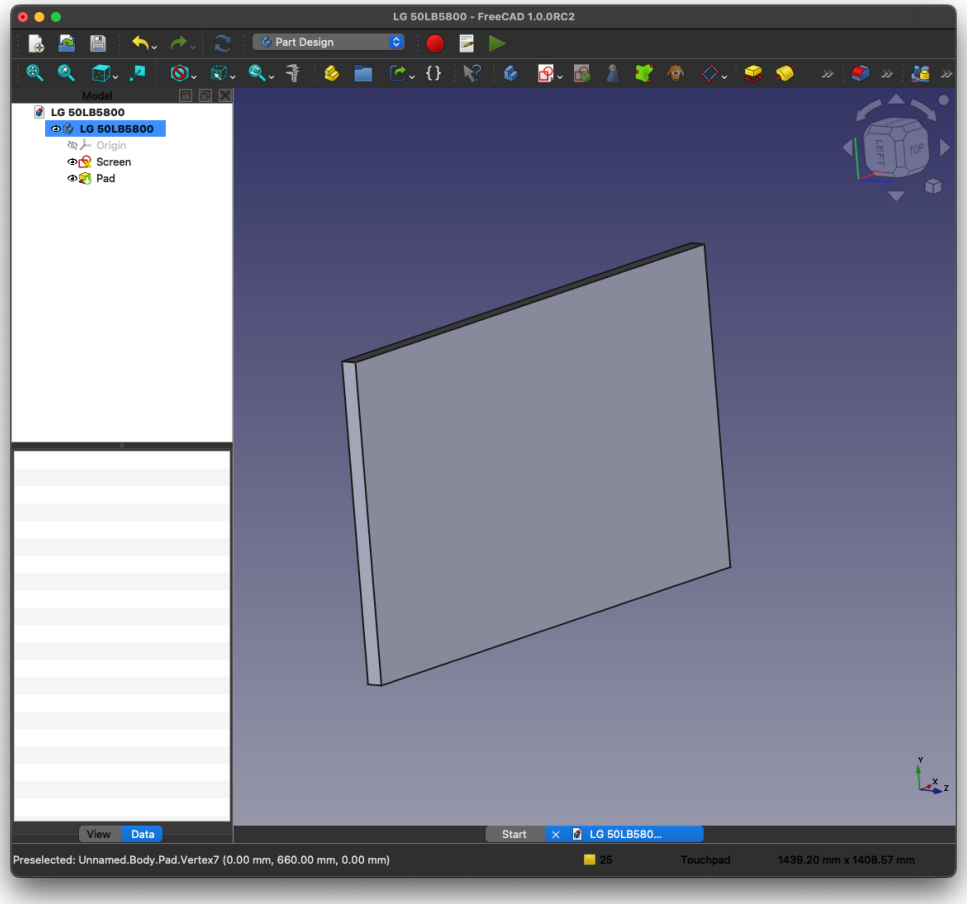

Figure 3: *Modeling the base of the TV in FreeCAD.*

By taking more measurements and using these basic operations (sketching and padding, and also a bit of filleting), I was able to arrive at my final 3D model.

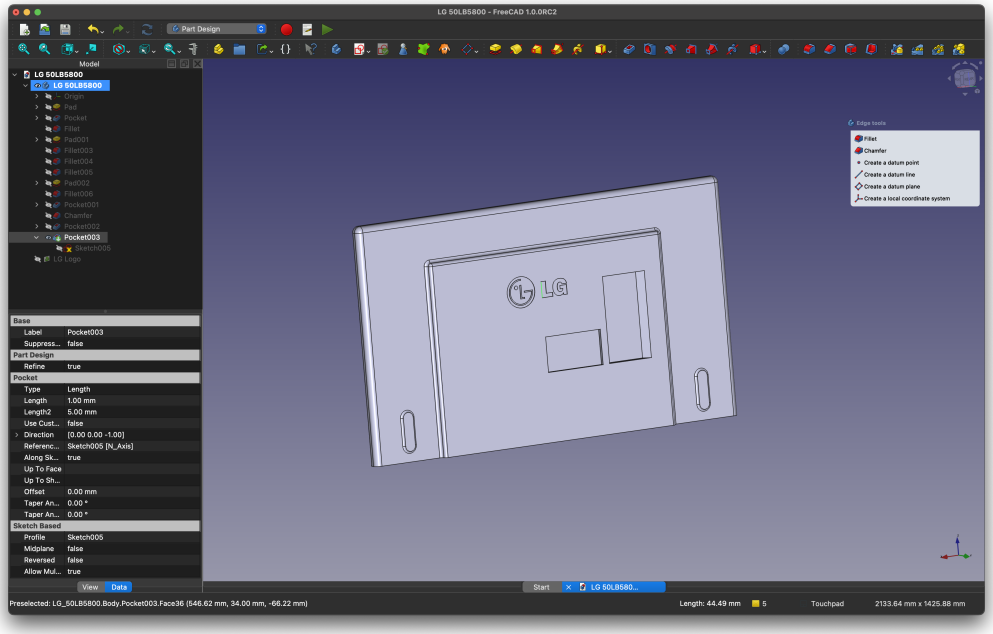

Figure 4: *My final 3D model of a 50LB5800 LG Smart TV.*

I decided to add the LG logo to the back of my model, just like the real one has. I sketched the logo on top of a reference image of the logo using regular sketch tools and B-splines for the curves of the G.

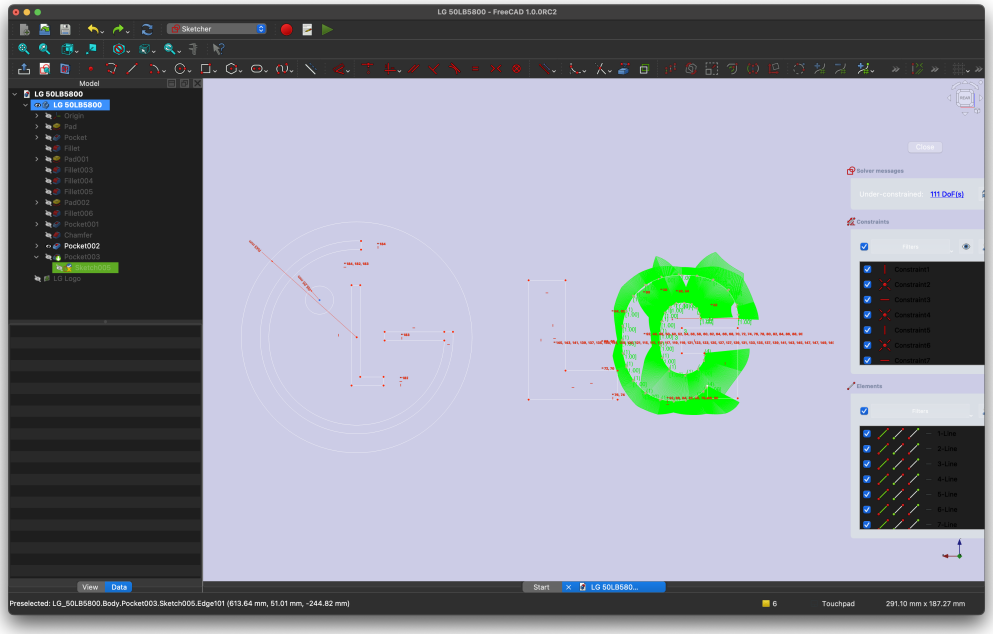

Figure 5: *Sketching the LG logo on the back of the 3D model.*

Once I was done modelling, I exported my 3D model as an STL file that slicing software can understand. I used UltiMaker Cura for slicing my model, as it is what Mr. McCallister recommended in class and is what he showed us the settings for. The settings used are shown in table 1. The model had to be scaled down for printing, as the 3D printer is small and this print was only a prototype anyway. The model was scaled in Cura to 15% of its original size.

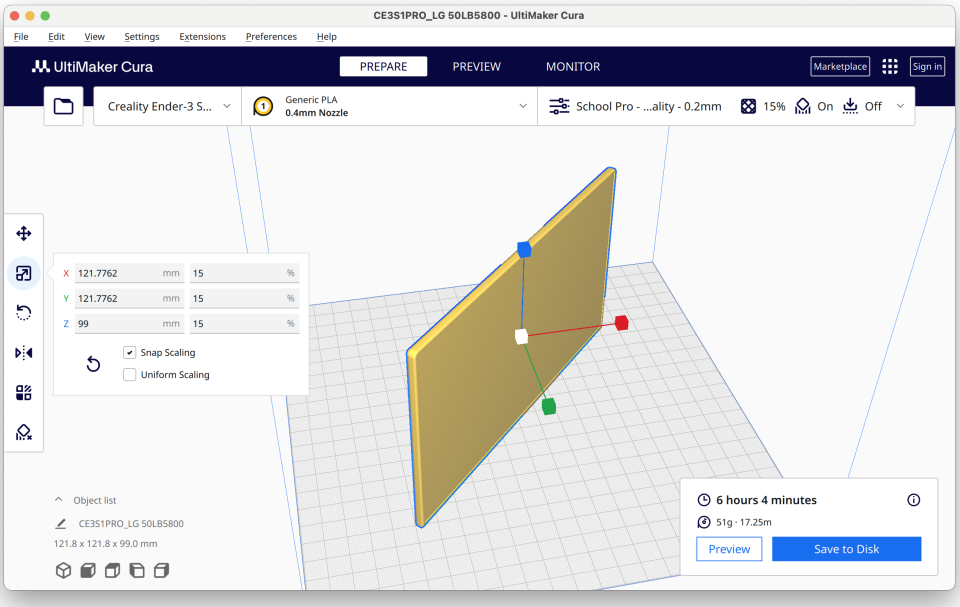

Figure 6: *Scaling and slicing the 3D model in UltiMaker Cura.*

Setting	Default Value	New value
Infill Density	20.0%	15.0%
Generate Supports	False	True
Support Structure	Normal	Tree
Printing Temperature	200.0 °C	215.0 °C

Table 1: *Settings used for slicing the model in UltiMaker Cura.*

Once the model was sliced into G-code, I saved the G-code onto an SD card and put it in one of the printers. After cleaning the print plate and applying some glue, I set it off to print. The first two prints failed, so I tried a different 3D printer and was able to get it to print well enough.

[TODO: Image of the printed 3D model.]

2. Criterion B: Product Production Inquiry

2.1. Production Questions and Addressing Strategies

- How does/did LG make the IPS LED displays for its LCD TVs?
  - Research LG LCD production process and the role of LG Display and LG Chem.
- What are the environmental impacts of LG's TV production process?
  - Research LG's sustainability initiatives and the environmental impacts of TV production.
- What are the ethical concerns with LG's TV production?
  - Research LG's conflict mineral policy and the ethical concerns with TV production.
- Where are the raw materials for LG's TVs sourced from?
  - Research LG's supply chain and raw material sourcing, and maybe the role of LG Electronics and LG Chem.

2.2. General Production Process

This specific model of the 50LB5800 LG Smart TV that I have at home was assembled in Poland, July 2014, as can be seen on the informational sticker on the back of the TV in figure 7. The TV was likely produced in the LG production plant in Mława, Poland (LG). The LG Display plant in Mława, however, was relocated to Wrocław in 2016 and is no longer operated by LG Display (Allen) (Evertiq AB), being sold to LG Chem instead (Shah). The TV was likely produced in the Mława plant before it was relocated. This model of the TV is also now discontinued and no longer produced (LG Smart TV With IPS Panel — LG UAE).

Figure 7: *The informational sticker on the back of my LG 50LB5800 Smart TV.*

Figure 8: *The LG plant in Wrocław, Poland. Image from Google Maps.*

The production process of the LG 50LB5800 Smart TV is not specifically documented, but it can be inferred from the general production process of LG TVs. Jeremy Kaplan, a former editor-in-chief of Digital Trends, visited the LG Display facility in Gumi, South Korea, and described the manufacturing process of LG's TVs.

> Because technology changes so rapidly, assembly lines are designed to be modular. They look impermanent, almost transient, the sort of thing you would put together yourself if someone told you to make one.
>
> Conveyor belts rolled along as straight as an arrow the entire length of the room, perhaps a quarter mile. Screens came down

from the ceiling to workstations where arms, either robotic or human, attached the few circuit boards required to transmit and process the picture.

Figure 9: *The LG Display facility in Gumi, South Korea (Kaplan).*

[TODO: Is this enough for criterion B?]

2.3. Ethical Concerns

As with any electronic device, there are ethical concerns with the production of LG TVs. The TVs will contain conflict minerals, like tin, tantalum, tungsten, and gold. These minerals are sourced from conflict regions, like the Democratic Republic of the Congo, and are often mined using child labor and under dangerous conditions (Hower). LG has a policy to avoid using conflict minerals, but it is difficult to ensure that all minerals are conflict-free (LG Electronics, Conflict Minerals — Business Partner — Sustainability — LG Global). In LG's Policy for Conflict Materials, LG states the following:

> LGE is committed to adopting, widely disseminating and incorporating principles in support of these goals in contracts, agreements and/or communications with suppliers. LGE expects our suppliers to have in place policies and due-diligence measures to facilitate the sourcing of minerals that are "DRC conflict free.[3)]" In addition, LGE requires our suppliers to comply with LGE's Supplier Code of Conduct, based on the Responsible Business Alliance (RBA) Code of Conduct, which sets forth LGE's broader standards for suppliers and includes provisions relating to human

> rights, ethical conduct, and environmental protection as well as additional provisions relating to conflict minerals.

LG, like most big companies, officially promotes ethically and environmentally good practices. However, often the reality doesn't live up to their public claims. For instance, in 2011, the British NGO Friends of the Earth released a report that showed the devastation caused by mining for tin on Bangka island in Indonesia. Around a third of the world's mined tin comes from Bangka and neighboring island Belitung. At the time LG said: "We can confirm that we do not directly source any products from Bangka, but our investigations have revealed that some of the tin used by our third-party suppliers may come from this region". So the company was, at this time, still involved in using tin that was being sourced unsustainably and unethically (Hower).

2.4. Raw Materials

As of 2023, LG has 249 suppliers of conflict minerals in 41 countries. Only two of these are in Poland, both conforming to LG's audit protocols. One of them is Fenix Metals, a supplier of tin, and the other is KGHM Polska Miedź, a supplier of gold (LG Electronics, LG Electronics Conflict Minerals Due Diligence Report). Tin is used for soldering electronic and metallic components, and gold is used for circuit board connectors (Brigham). An example of where these minerals are used in the LG 50LB5800 Smart TV is in its mainboard, as seen in figure 11, which contains gold connectors and tin soldering.

2.4.1. Fenix Metals: Tin Supplier

Fenix Metals is a tin recycling company in Poland, that manufactures "quality tin and alloys from recycled tin residues" (Fenix Metals, Fenix Metals — World Class Tin Recycling). Fenix Metals is a supplier of tin to LG, which is used in the soldering of electronic and metallic components in LG TVs. Fenix Metals don't source their tin from conflict regions, and are a member of the International Tin Association (International Tin Association, OUR MEMBERS - International Tin Association), which promotes responsible and sustainable tin production (HERITAGE & VISION - International Tin Association).

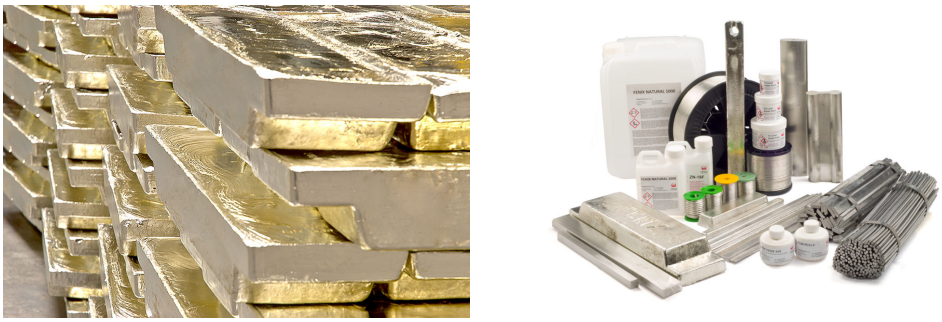

Figure 10: *Fenix Metals' tin ingots and other products (Our Products).*

Fenix Metals accepts tin residues from its suppliers, which are then processed and refined into tin and tin alloys. The company does not state the process used to process and refine the tin, but it is likely that they use a smelting process to extract the tin from the residues. The smelting process involves heating the tin residues to high temperatures to melt the tin, which then produces a pool of molten tin and scoria containing impurities. The molten tin is then made into large slabs that can be further refined, and the scoria is retreated to extract any remaining tin (Barry).

There are several methods for refining tin, such as fire refining and electrolytic refining. Fire refining involves heating the tin to high temperatures to remove impurities, while electrolytic refining uses electricity to remove impurities from the tin. Fire refining tends to be most commonly used and produces up to 99.85% pure tin, while on the other hand, electrolytic refining produces up to 99.999% pure tin (Barry).

An example of where Fenix Metals' tin is used in the LG 50LB5800 Smart TV is in the soldering of the PCB, as seen in figure 11. The mainboard also goes through a surface treatment process called immersion tin. Immersion tin involves replacing copper with tin on PCB solder pads, and has several advantages and disadvantages. Some advantages include increased solderability, versatility, and environmental friendliness, while some disadvantages include quicker oxidation and soldering reliability issues (J.).

Figure 11: *The LG 50LB5800 Smart TV mainboard (TV Parts Canada).*

2.4.2. KGHM Polska Miedź: Gold Supplier

Gold is used in several parts of the TV, such as the PCB, connectors and microchips. Gold is used in gold plating for the PCB for efficient and reliable electrical connections, in connectors for its low resistance and good durability, and in microchips for its high conductivity (Elmore).

Figure 12: *KGHM Polska Miedź's gold bars (KGHM Polska Miedź).*

KGHM exports gold bars to LG, which are used in the production of circuit board connectors in LG TVs. The bars weigh one of 0.5kg, 1kg, 4kg, 6kg or 12kg, and are guaranteed to have no more than 100ppm of impurities. The gold bars are produced from anode slime, a byproduct of the electrolytic silver refining process. The anode slime is processed in hydrometallurgical processes to extract the gold, which is then melted in an induction furnace and cast into gold bars. The gold bars are then exported to LG for use in the production of circuit board connectors (KGHM Polska Miedź).

3. Criterion C: Product Map

The LG 50LB5800 Smart TV goes through several stages in its lifecycle, from raw material extraction, to production, to distribution, to consumption, to disposal. The map in figure 13 shows the relevant locations in the lifecycle of the LG 50LB5800 Smart TV.

The map was created using Google My Maps, a web mapping service that allows users to create custom maps with markers, lines, and shapes. Interactive versions of the map can be found online on Google Maps and on Google Earth.

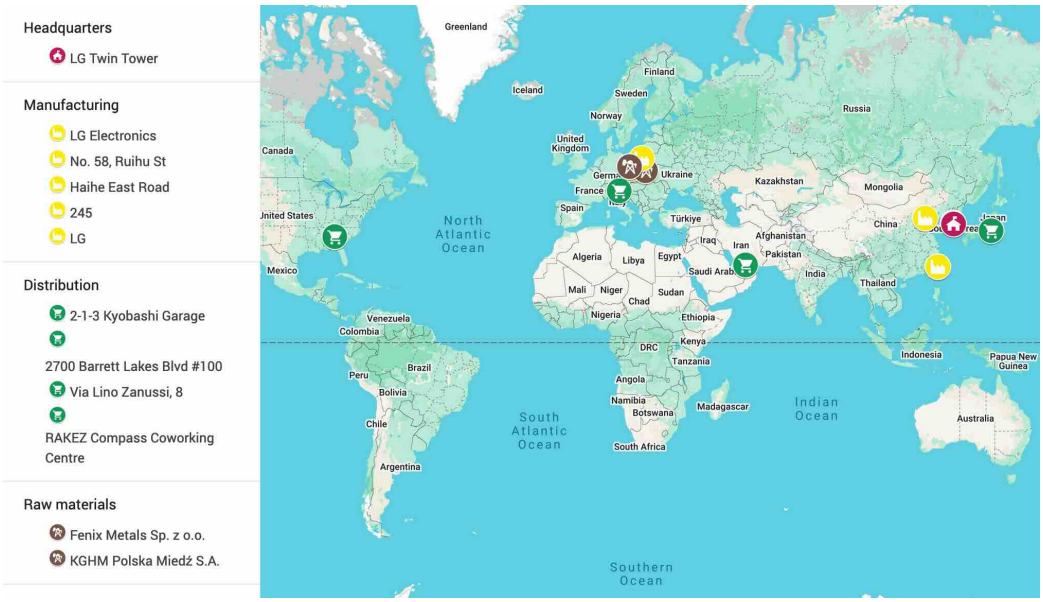

Figure 13: *Map of relevant locations in the lifecycle of the LG 50LB5800 Smart TV.*

4. Criterion D: Product Lifespan, Disposal, and Impact

The television that I found was made in July 2014. Our neighbours discarded it this year. It has lasted 10 years. On average, modern televisions last 10 years, so it has lasted the average length of time. According to "Smart TV Club", LG televisions last as long as Samsung products, but not as long as Sony ones, which can potentially last a year or two longer (R.).

This television switches on, so it seems that the problem is a faulty connection, a copper wire or the tin solder.

The internal components within a TV play a big role in its lifespan. Better quality components typically lead to better heat dissipation and durability. Manufacturers may want to save on production costs by using cheaper components, thereby increasing profits. Although this is good for their profits, it's detrimental to the environment, as more resources will be needed to make more new televisions to replace the ones that break quicker.

There are, however, ways to extend the lifespan of a TV. One way is to keep it clean and dust-free. Dust can accumulate on the internal components

of a TV, causing them to overheat and fail. Another way is to keep the TV in a well-ventilated area. TVs need to be kept cool to prevent overheating. Overheating can cause the internal components to fail. A third way is to avoid power surges. Power surges can damage the internal components of a TV, causing them to fail. A surge protector can be used to protect the TV from power surges. Software updates can also help extend the lifespan of a TV. Software updates can fix bugs and security vulnerabilities, preventing the TV from malfunctioning or being hacked (R.).

When the television no longer works, it has to be disposed of. LG says it has a "global take back and recycling policy" (LG Electronics, Global Take-Back Policy — Take-Back & Recycling — LG Global). However, as a Spanish resident, I am not aware of any such scheme here. If the companies do have such schemes, they are not well publicised. For instance, I found the TV left out on the pavement by our neighbours for the normal trash collectors to take. It is better to take your electronic products to a "punto limpio" or municipal waste processing site, from where the authorities try to recycle as much as they can. In 2020 Spain collected 393.800 tonnes of electronic waste (IT Digital Media Group). Globally, less than a quarter of e-waste produced in 2022 was known to be formally recycled. Recycling the e-waste is important to save the minerals used in the product to prevent their waste, and also to prevent polluting the environment, e.g. improper disposal of e-waste often leads to lead and mercury being released into the environment (World Health Organization).

In Europe, the EU has the goal for recycling 50% of electronic waste by 2025 (next year), but Spain currently only recycles about 35% of its e-waste (Miogas). The US, which is among the largest producers of e-waste, has no federal law mandating the recycling of electronics (Ramirez). Most electronics companies don't make much effort to offer recycling projects, as currently this is an extra cost for them that is not mandatory. Therefore the state is left with the cost of the e-waste disposal, so the consumer is paying for it with his or her taxes.

Global e-waste in 2022 was up 82% compared to 2010, according to the UN report "Global E-waste Monitor" released this year, and is growing five times faster than rates of recycling, meaning that the recycling rates are due to actually decline. When this e-waste cannot be recycled properly, it causes a lot of environmental problems, eg leaching lead and mercury into the environment. Most of it ends up in landfills, and it is common for wealthy countries to dump e-waste in poorer developing countries, where

they don't have the infrastructure to recycle it safely (Ramirez). Jim Puckett, the founder and executive director of the Basel Action Network, an e-waste watchdog group, said that manufacturers are showing "a lack of duty of care" by failing to take accountability for what happens to their products at their end of life. "Manufacturers have to be dragged, kicking and screaming", to make products that last, he said, "and not just design products for the dump, hoping they can sell us a new one as soon as possible". Manufacturers need clear plans for the removal, collection and recycling of the toxic and hazardous parts of their products. This includes companies like LG.

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