Foxway

Giving new life to used smartphones:
Estimating the positive impact of
Foxway using the handprint approach

Handprint Report: Mobiles

2023

Content

Key terms and definitions

Carbon footprint: The total amount of greenhouse gas emissions (expressed in carbon dioxide equivalents) that are generated by an individual, event, organization, service, or product from within a specified boundary.

Carbon handprint: An indicator of the climate change mitigation potential. Describes the GHG emission reduction in a user's activities that occurs when the user replaces a baseline solution with the offered solution.

Baseline: A reference case that best represents the conditions most likely to occur in the absence of an offered solution. A product, a service or a product chain which delivers the same function(s) to the user as the offered solution and is used for the same purpose(s) by the users(s) within a specific time period and region. The offered solution is compared to the baseline with respect to its footprint.

CO_2e: A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

EOL: End-of-life. In the context of product life-cycles, EOL is the final stage of a product's existence.

GHG: A gas that contributes to the natural greenhouse effect. The Kyoto Protocol covers a basket of six greenhouse gases (GHGs) produced by human activities: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

ICT: Information and communication technologies.

ISO: International Organization for Standardization is the world's largest developer of voluntary international standards and it facilitates world trade by providing common standards among nations.

LCA: Life-cycle assessment. A methodology to quantify and assess the inputs, outputs and potential environmental impacts of a product system throughout its life-cycle (ISO 14040; ISO 14067:2018).

WEEE: Waste electrical and electronic equipment, i.e., e-waste.

Background

Increasing amounts of e-waste coupled with low collection and recycling rates...

- E-waste is one of the fastest-growing waste streams. In 2019, approximately **53.6 million tons (Mt) of e-waste** was generated globally (which brings to an average of 7.3 kg per capita), fuelled by increasing consumption rates of electrical and electronic equipment, dropping price of ICT products, their short life cycles, and relatively few repair options. E-waste generation is expected to increase to 74.7 Mt in 2030 and reach as much as 110 Mt in 2050 (Baldé et al., 2022).
- At the same time, **only 17% of that waste was formally collected and recycled** – the fate of the rest is uncertain, but majority is probably mixed with other waste streams, like plastic and metal, and even if it is (partly) recycled, it is often done under inferior conditions.
- Europe has the highest collection and recycling rate compared to other continents (42.5% in 2019), but neverth-eless, recycling activities are not keeping pace with the global growth of e-waste (Baldé et al., 2022).

...have led to negative environmental impacts, loss of valuable finite resources, and growing pressure on the planet

- Recent trends show that **smartphones replacement cycle has become on average shorter than two years** (Cordella et al., 2021). As the main contributor to the carbon footprint comes from the production phase (mostly over 80%), and the pressure on raw materials is caused by the same phase as well, this constant demand for new smartphones leads to significant increase in environmental impacts. The contribution of smartphones to the global GHG emissions caused by ICT sector is rapidly growing. In 2020 smartphone` s were projected to be responsible for **11% of the total ICT impact**, which exceeds those of desktops (6%), displays (7%), and laptops (7%) (Belkhir et al., 2018, Charfeddine and Kahia 2021).

- It is argued, that energy efficiency improvements in new products justify replacing old products due to lower energy demand. However, a 2019 report by the European Environmental Bureau showed that **a smartphone should be used for a minimum of 25 years** to compensate for the GHGs linked to their non-use phases.
- Extending the service life of old devices by repairing them, on the other hand, saves energy and finite resources that would otherwise be consumed in the manufacturing of new products, which carries considerable negative impacts on the environment.

Foxway's recommerce business helps to alleviate this issue by extending the total service life of ICT products

Foxway's asset recovery services give smartphones **a longer life** – we buy used or damaged mobile phones; screen, sort, and test them; perform a regulation-compliant full data wipe; and repair as much as possible. Redeemed devices are then sold through a network of resellers, thus being gifted a second lifetime.

This potentially brings significant environmental benefits. Indeed, **the extension of the service life of ICT products has been identified as the key strategy to minimize the total environmental impact of ICT products** (Prakash et al., 2012, Bakker et al., 2014). According to a 2019 report by the European Environmental Bureau, **a 1-year lifetime extension of all smartphones in the EU would save 2.1 Mt CO_2e per year by 2030**, the equivalent of taking over a million cars off the roads.

Fortunately, there's a market demand for sustainable products and services and at least European consumers are becoming more open to buying used electronics. International Data Corporation forecasts worldwide **market for used smartphones to grow with a compound annual growth rate of 10.3 % from 2021 to 2026** (IDC, 2023).

Foxway's ambition

- Foxway's ambition is to be the top company in Europe for sustainable IT services and recycling, leading the way with circular solutions that go beyond the industry's traditional linear consumption models.
- Extending ICT products' service life undoubtedly brings environmental benefits. To build a stronger foundation for our sustainability efforts, calculating our positive impact on the environment is a necessary step.
- In line with the above, the current study was done to quantify the positive impact of refurbished laptops. The study was commissioned from an external LCA consultancy (Sustainability Services OÜ).

Purpose of this study

Is to estimate the climate impact and advantage (compared to buying a new device) of a typical* Foxway's refurbished smartphone.

For this reason, a partial life cycle assessment (LCA) was conducted to quantify the GHG avoidance of refurbishing smartphones, following the Carbon Handprint methodology (see next page for more details.

** By typical we mean an average refurbishment scenario for a Foxway smartphone (Apple vs Android or other smartphones were analysed separately).*

Estimating Foxway's positive impact using the Carbon Handprint methodology

- In contrast to carbon footprint, which refers to the negative environmental impact throughout the life cycle of a product, the term handprint refers to the positive environmental impact of a product throughout its life cycle (Pajula et al., 2021).
- The purpose of carbon handprint assessment is to calculate the beneficial greenhouse gas impacts of a product compared to an alternative solution (i.e., the baseline solution).
- This fits well with Foxway's goal of being an ESG enabler since our asset recovery services help our clients improve their sustainability performance by avoiding unnecessary carbon emissions. We can communicate the climate benefits of using refurbished IT devices following the handprint methodology.

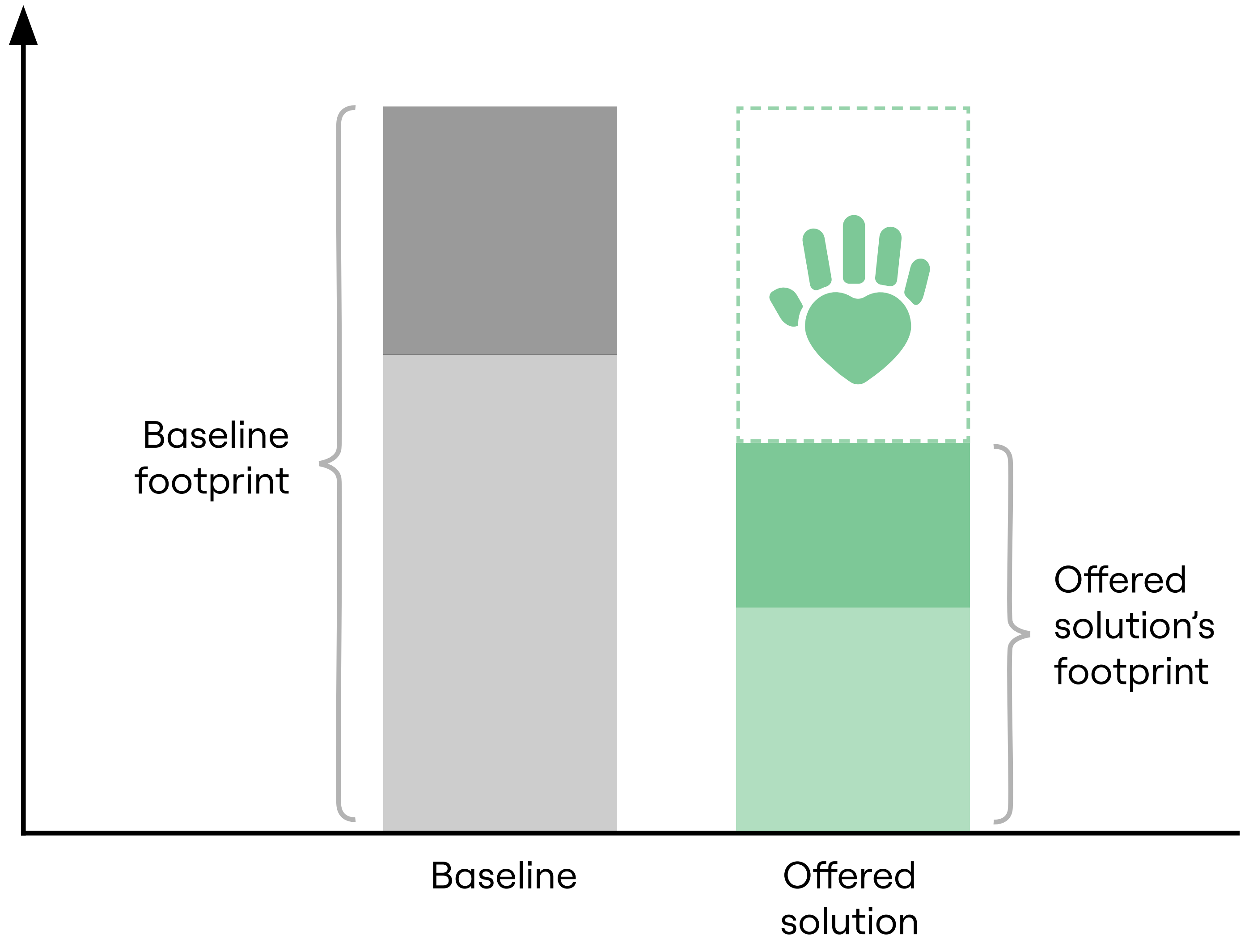


Figure 1. A handprint can be created by offering solutions with a lower footprint in comparison to the solutions used in the baseline.

Source: Pajula et al., 2021. Carbon Handprint Guide v2.

Handprint calculation itself is a simple equation that is based on carbon footprint calculations following **ISO 14040-44** and **ISO 14067** standards, which specify principles, requirements and guidelines for life cycle assessments (see next page for more details).

$$\text{Handprint}_{\text{Product}} = \text{Footprint}_{\text{Baseline}} - \text{Footprint}_{\text{Offered solution}}$$

Where:

Footprint Baseline = production of a new smartphone and its transport to customer

Footprint Offered Solution = refurbishing an old smartphone and its transport to customer (aka the "Foxway's solution")

Foxway's Handprint is based on a partial life-cycle assessment

- Life-cycle assessment is a quantitative analysis of the environmental aspects of a product over its entire life cycle, from raw material extraction (cradle) to end-of-life (grave). Accordingly, a full life-cycle assessment is called cradle-to-grave.
- For estimating Foxway's positive handprint, **a partial life-cycle assessment was conducted** to determine the climate impact of refurbished smartphones. Specifically, processes **from raw material extraction until (and including) distribution to customers were considered**, leaving out the climate impact of the use phase and end-of-life stage.
- This is in line with the ISO standards* for life-cycle assessment, which allow excluding phases that are considered to be equivalent when comparing the life-cycle impact of two (or more) alternative solutions.
- In other words, since the use phase and disposal/recycling for baseline solution and Foxway solution can be assumed to have equal climate impact, including them in the calculation would not influence the final outcome of the handprint calculation.

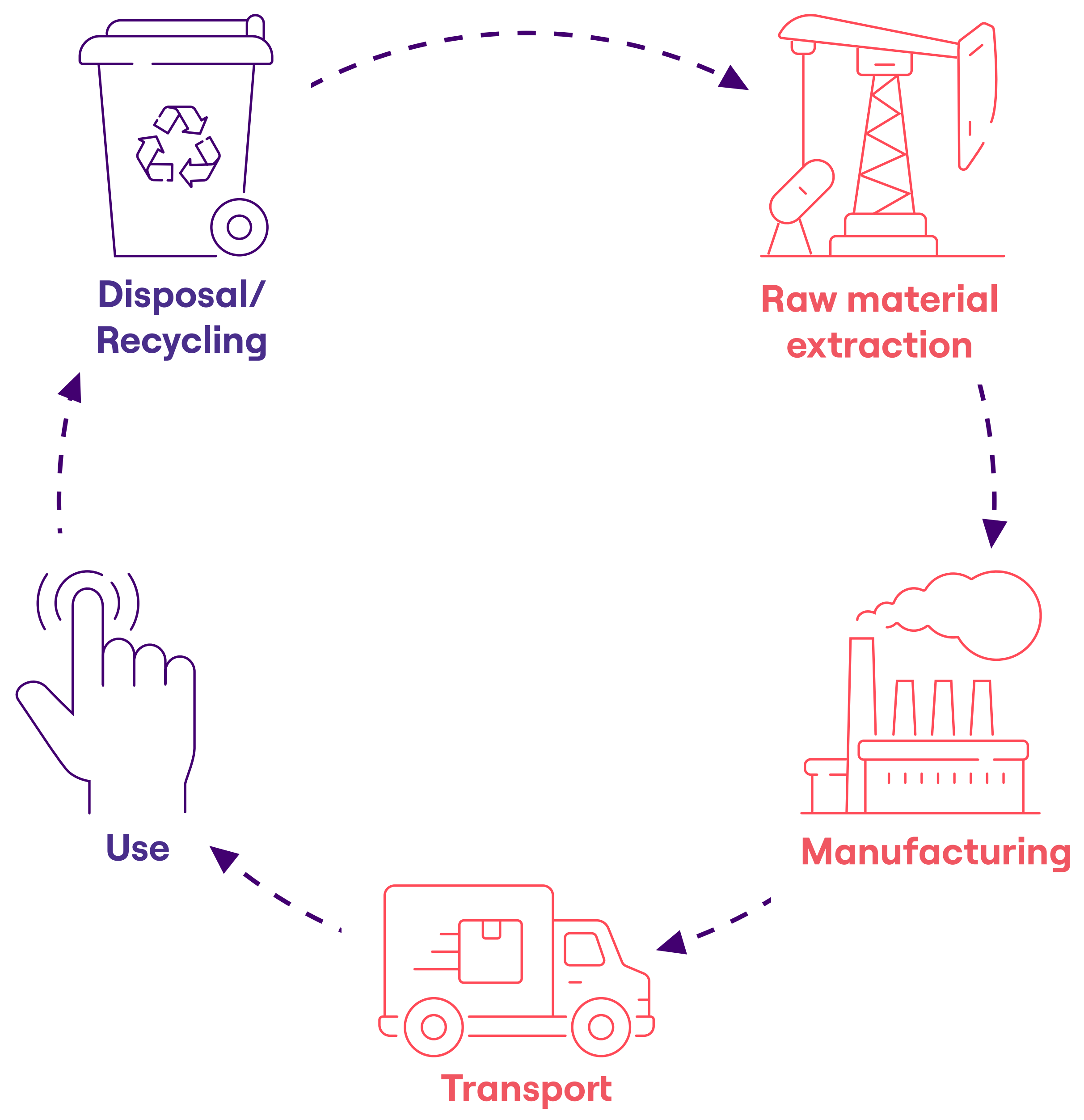


Figure 2. Product's life-cycle. Phases included in the calculations of the current study are depicted in red.

** ISO 14044 and ISO 14067. The former specifies requirements and provides guidelines for life cycle assessment, whereas ISO 14067 specifies principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product in a manner consistent with ISO 14044.*

Methodology

Identification of the operating environment

- The buyers of a refurbished smartphones are environmentally aware consumers or companies that value sustainability and are concerned about the environmental impact of their purchasing decisions.
- The functional unit for this study is: one smartphone with expected use phase of 2 years.
- A cradle-to-gate (incl. emissions until the point of sale) LCA was done for this study – life cycle stages starting from manufacturing and ending with transport to the customer. Considering the assumed functional equivalence of smartphones in both scenarios, the use phase, transport to EOL, and EOL processing are considered identical in both solutions and thus can be left out of the equation as they do not affect the comparison.
- Data to calculate carbon footprint of the offered (Foxway) solution was gathered from Foxway (such as electricity and heat use, smartphones' and repair parts' import and export information, handled devices and parts' amounts, the use of consumables). The data was collected for the period from Sept 1st, 2022, to Aug 31st, 2023. In addition, some information was obtained from different web-based databases (e.g. transport distances). Impact assessment data was obtained from the Ecoinvent v3.9.1 database (model 'Cut-off', impact assessment method IPCC 2021 GWP100), various electronics companies' products' environmental reports and declarations and from relevant scientific literature.
- Baseline is an alternative solution to buying a refurbished smartphone. Defining the baseline is necessary to compare the offered solution to business as usual, i.e., "common" practice. Current baseline description: customer buys a brand-new smartphone. Carbon emissions reduction in this study comes from the decrease in energy and resource demand which would have been needed to manufacture and transport a new smartphone.
- Secondary data for the baseline solution was gathered from various product environmental reports and declarations published online.

Carbon handprint is always quantified for a specific situation and a specific type of user.

The selection of the functional unit and system boundary must be consistent with the goal of the study and equal in baseline and offered solutions.

System boundaries of the life-cycle assessment

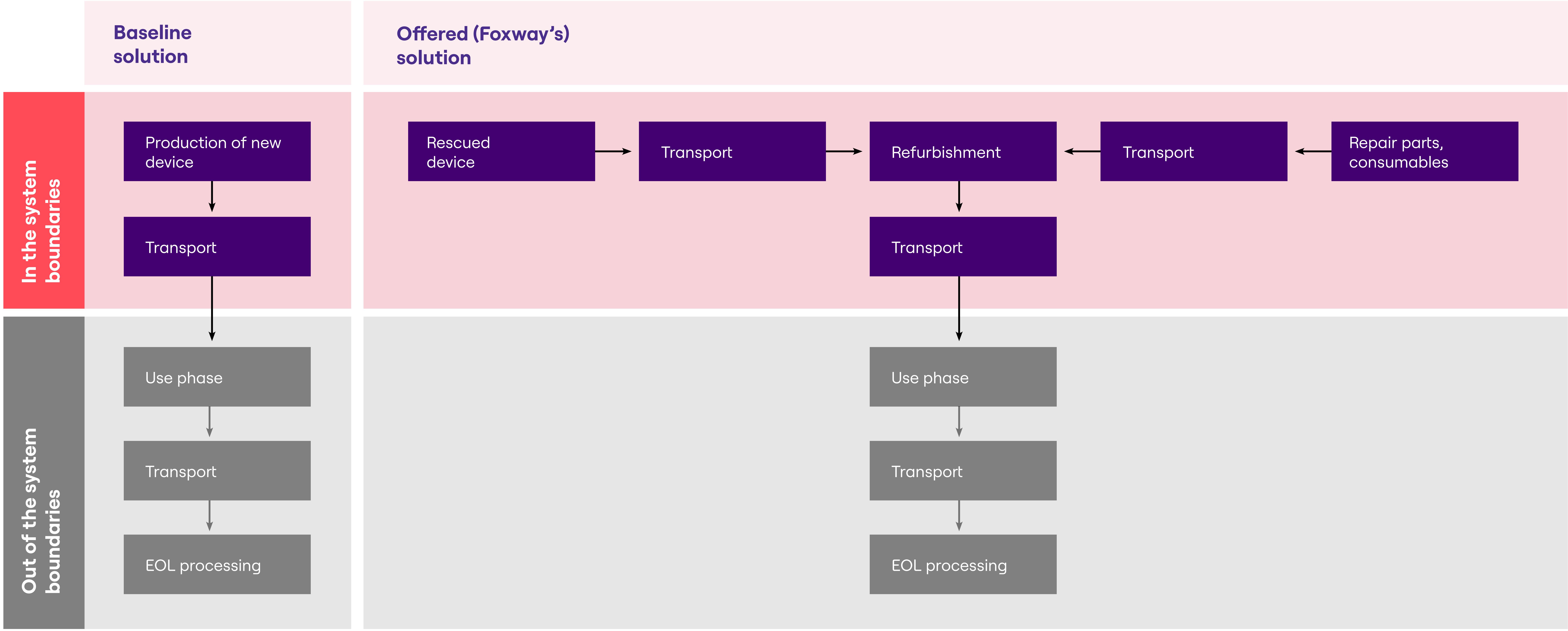


Figure 3. Life-cycle system boundary

Description of the processes that contribute to the footprint calculations

Refurbishment scenario of the Foxway's solution

Smartphone import

Foxway imports used smartphones via road transport (51%), air transport (31%) and sea transport (18%). The starting point is generalized to the country capital (e.g if the device is imported from Sweden, the distance is measured between Stockholm and Foxway in Tartu, Estonia).

Product repair

There are two scenarios for refurbishment:

- repairs with parts (36 % Apple phones, 29% Android and other phones)
- repairs without parts (64% Apple phones, 71% Android and other phones).

Average carbon emissions emanating from the transport of brand new spare parts was calculated by analyzing different transport types (land, air, water), distance (km) and their usage in refurbishment.

To calculate the transport emissions of reused parts, device import transport data was used, as reused parts come for the devices that are not repairable. The values were quantified with the average reused part weight.

The use of main consumables (glue, primer, polish and cleaning agents) was also included in assessment.

Energy demand

Foxway's buildings heat and electricity demand was also accounted for. Energy demand was calculated per device to estimate the energy need of the refurbishment process.

Device export

Once the smartphones are refurbished, they are exported via air transport (65%), road transport (33%) and sea transport (2%). Again, the destination is generalized to the country 's capital.

Baseline Scenario

Carbon footprint of baseline scenario is based on published carbon footprint of Iphone 11 to 15 models with different storage capacities – a total number of combinations of different models and storage capacities was 65. Other producers publish carbon footprint information only for a very limited number of models and it is not always the most recent data. Therefore, the footprint data of Iphones was used as a baseline for both, Apple and Android (and other) smartphones. For the baseline carbon footprint value, only the life cycle stages until the transport to the client were included (as explained in pages 11 and 12).

To consider the different functionality of smartphones, the share of storage capacity of annually sold smartphones by Foxway was used as a basis to calculate the weighted average carbon footprint of baseline scenario.

Capacity	Apple	Android (and others)
16 GB	2.9%	5.0%
32 GB	7.9%	8.9%
64 GB	46.8%	15.4%
128 GB	27.8%	49.9%
256 GB	12.9%	14.0%
512 GB	1.2%	2.4%
1 TB	0.2%	0.2%
Over 1 TB	0.2%	4.0%

Important presumptions behind the calculation

1. The rescued phone is considered waste, because:

- Nearly all phones that Foxway handles are at least 2 years old, and since about 2 years is considered an average expected lifetime of a smartphone (based on several scientific articles and reports*), the assumption has been made to regard the used phones as saved from disposal. Recent trends show that smartphones replacement cycle has become on average even shorter than two years (Cordella et al., 2021).
- Product lifetime is influenced by several factors: consumer behavior, socio-economic aspects and technology change. As people mostly keep their old devices at home (Eurostat, 2023), the performance of such ICT equipment will degrade, and they will be disposed in the future.
- During the refurbishment, the phone's performance is enhanced to extend its lifespan. Without the refurbishment, the phone would most probably be disposed after first use, as consumers generally assume products, especially electronics, will only last for short periods (Wieser et al., 2015). This supports the presumption that if Foxway would not collect the used phones, they would most likely reach EOL.

** Cordella et al, 2021; EP, 2016; Manhart et al, 2012; Tröger et al, 2017*

2. The refurbished laptop is assumed to be functionally approximately equivalent to a new device and is assumed to be used for another 4 years.

- Refurbished laptop is assumed to be functionally equivalent to a new device. Products are functionally equivalent or approximately equivalent if they share a set of obligatory properties including the main function (Andre et al., 2018).
- It is assumed that both laptops can be used for the same purpose and for the same time period, as their technical specifications are presumed to cover a similar performance.

3. The use and EOL phases of the baseline and handprint solutions are considered to be equivalent, because:

- Considering the assumed functional equivalence of laptops, the use phases and disposal are identical in both alternatives and do not affect the comparison, therefore eliminating the need to be assessed during this study. To highlight the differences between the alternatives, the results are presented without the contribution of the use and EOL phase.
- Real-life climate impacts of the use phase, transport to EOL and disposal are consumer specific and depend on several factors (for instance, the source of electricity used when the device is charged), and these can be considered the same across both the baseline and handprint scenarios.

Results

Baseline solution's climate impact: Production of a new smartphone and transport to consumer causes...

- Carbon footprint (kg CO_2e) of the baseline solution is based on Iphone 11 to 15 models – a total number of combinations of different models and storage capacities was 65. Data was obtained from respective environmental reports.
- An average carbon footprint of a new smartphone is 71 kg CO_2e (weighted average considering the share of storage capacities of annually sold smart-phones by Foxway). This value expresses the full life cycle impacts, including the use and EOL phases.
- The main source of greenhouse gases is the phone production, as around 82% of the impact derives from this stage. Transport to user constitutes on an average 3%, and the rest is caused mainly by the use phase. EOL contributes less than 1%.
- Since use phase and EOL are not included in the system boundaries, baseline carbon footprint (production + transport) equals:
58 kg CO_2e + 2 kg CO_2e = 60 kg CO_2e

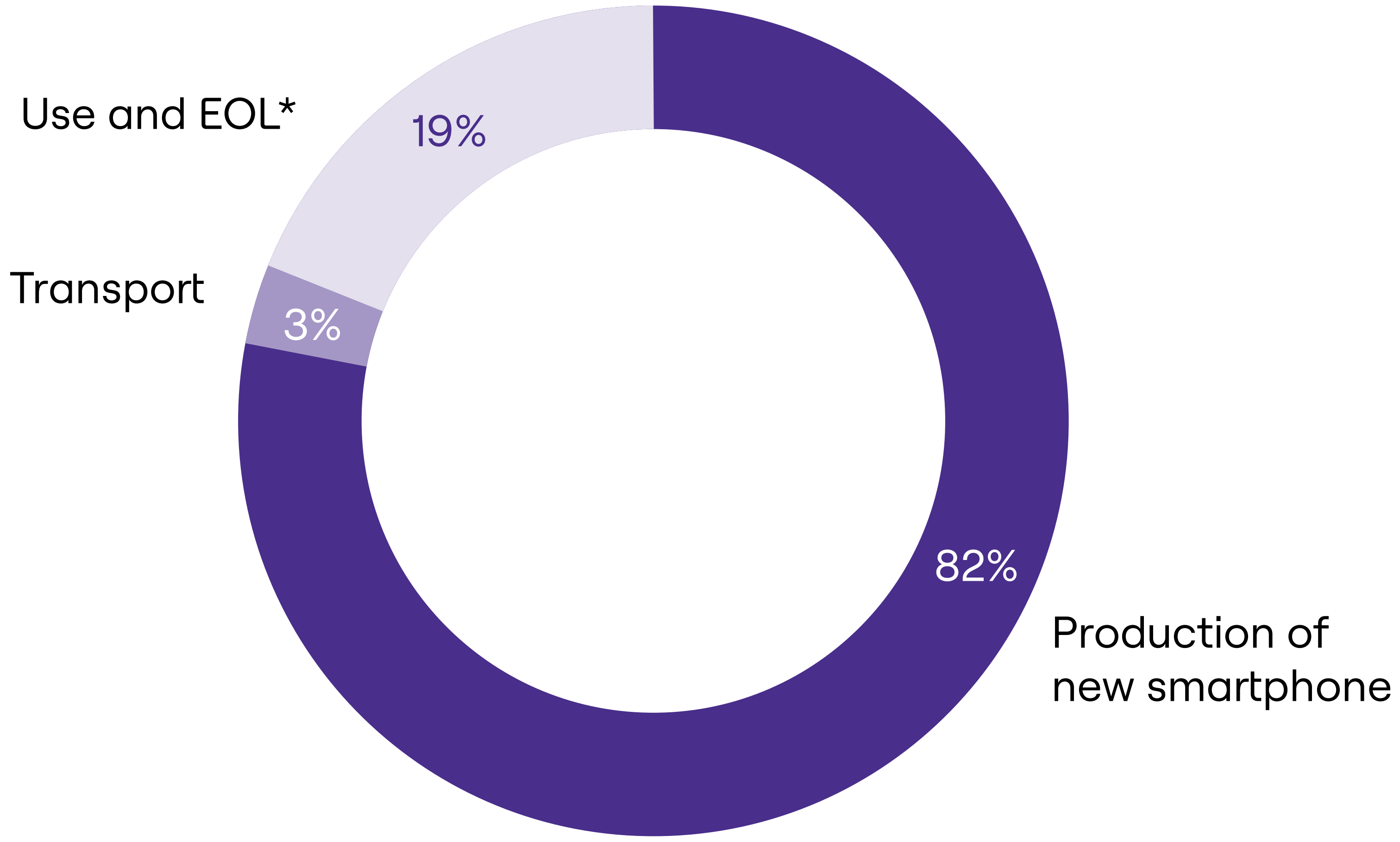


Figure 4. Carbon footprint of baseline solution
**Use and EOL are out of the system boundaries of this study*

...60 kg CO_2e emissions

Offered solution's climate impact: Refurbishment & transport of a Foxway smartphone to the customer causes...

- Smartphone's transport to Foxway (import) emits on average roughly **0.15 kg CO_2e**, energy input to refurbishment processes (electricity and heat use in the factory) **0.44 kg CO_2e**, spare parts production and transport to Foxway **0.39 kg CO_2e**, use of consumables and transport between Foxway facilities in Tartu, Estonia **0.02 kg CO_2e** (referred as "Other" in Fig. 5), and refurbished phone's transport to customer (export) emits **0.58 kg CO_2e**.
- All these add up to a total climate impact of **1.58 kg CO_2e**.
- Considering that the used phone is handled as waste, it carries no production legacy. The biggest contribution is caused by the transport of refurbished smartphones to the client (export), following the electricity and heat use in company facilities in Tartu, Estonia, and the production and transport of parts which are used to refurbish the mobiles. Most of the part-related impact is caused by the production of brand-new spare parts.

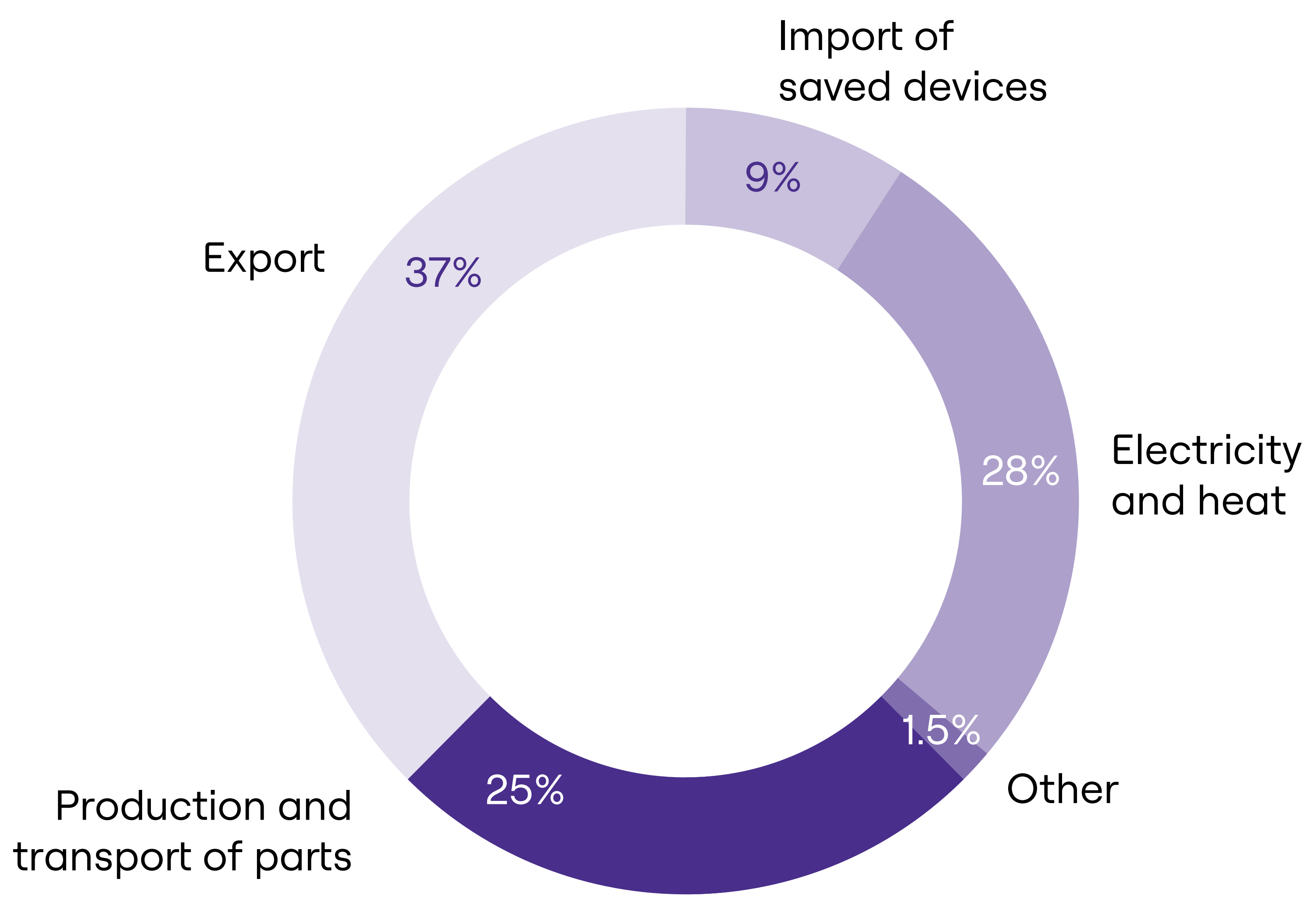


Figure 5. Carbon footprint of offered (aka Foxway's) solution for Apple smartphones

...1.58 kg CO_2e emissions for Apple smartphones

Offered solution's climate impact: Refurbishment & transport of a Foxway smartphone to the customer causes...

- Smartphone's transport to Foxway (import) emits on average roughly **0.15 kg CO_2e**, energy input to refurbishment processes (electricity and heat use in the factory) **0.44 kg CO_2e**, spare parts production and transport to Foxway **1.93 kg CO_2e**, use of consumables and transport between Foxway facilities in Tartu, Estonia **0.02 kg CO_2e** (referred as "Other" in Fig. 6), and refurbished phone's transport to customer (export) emits **0.58 kg CO_2e**.
- All these add up to a total climate impact of **3.13 kg CO_2e**.
- Considering that the used phone is handled as waste, it carries no production legacy. The main source of emissions derives from the production and transport of parts which are used to refurbish the mobiles, and majority of it is caused by the production of brand-new parts. The second biggest contributor is the transport of refurbished smartphones to the client (export), following the electricity and heat use in company facilities in Tartu, Estonia.

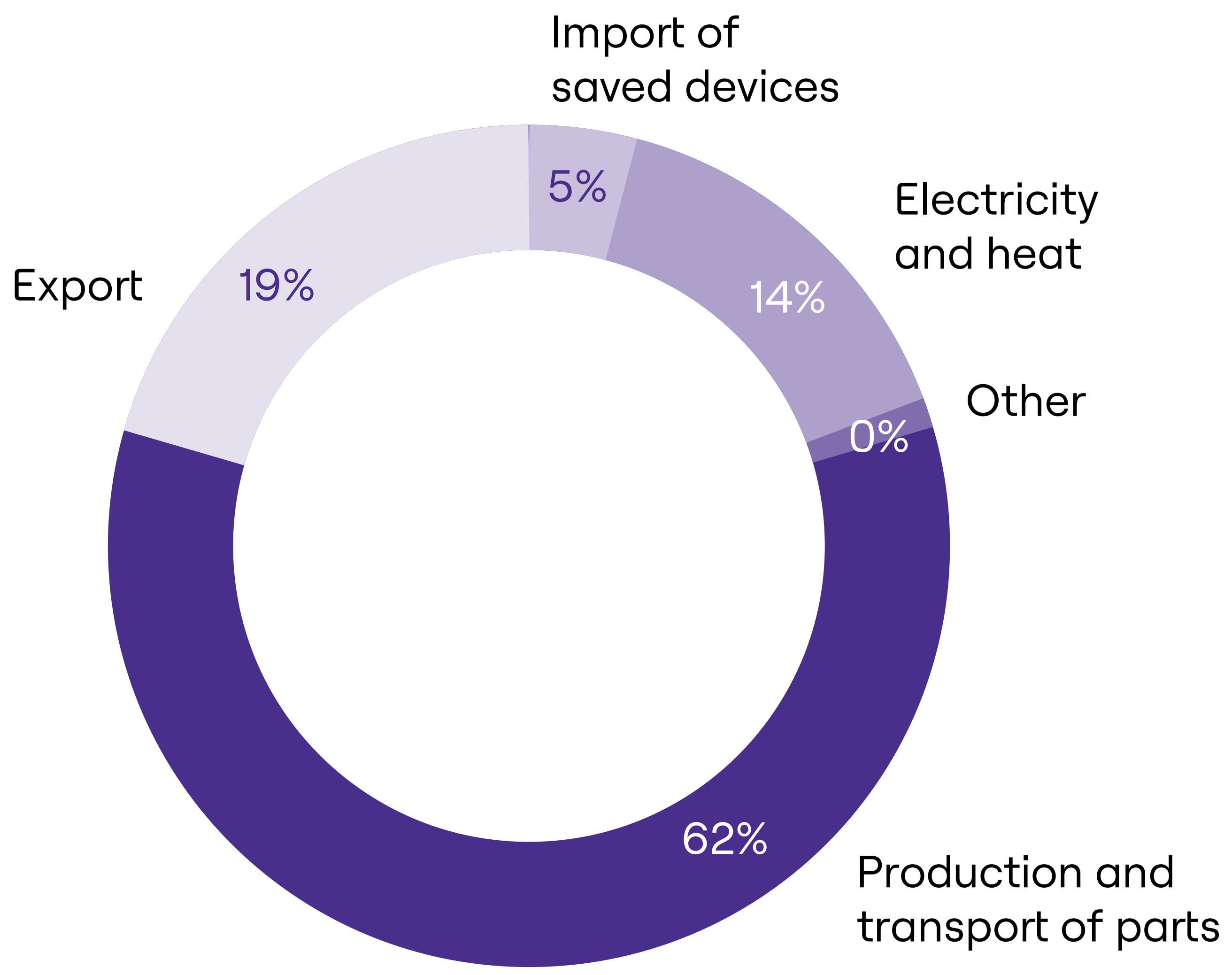
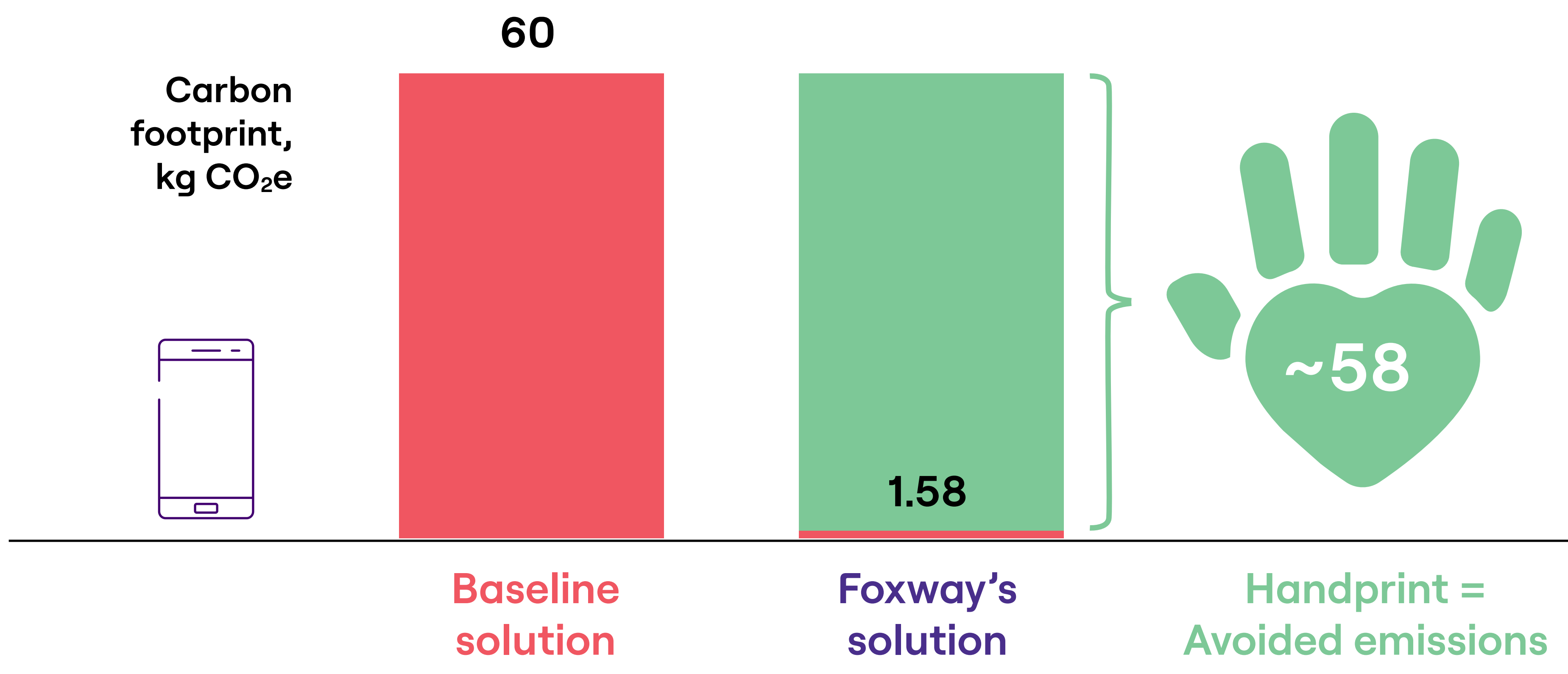


Figure 6. Carbon footprint of offered (aka Foxway's) solution for Android (and other) smartphones

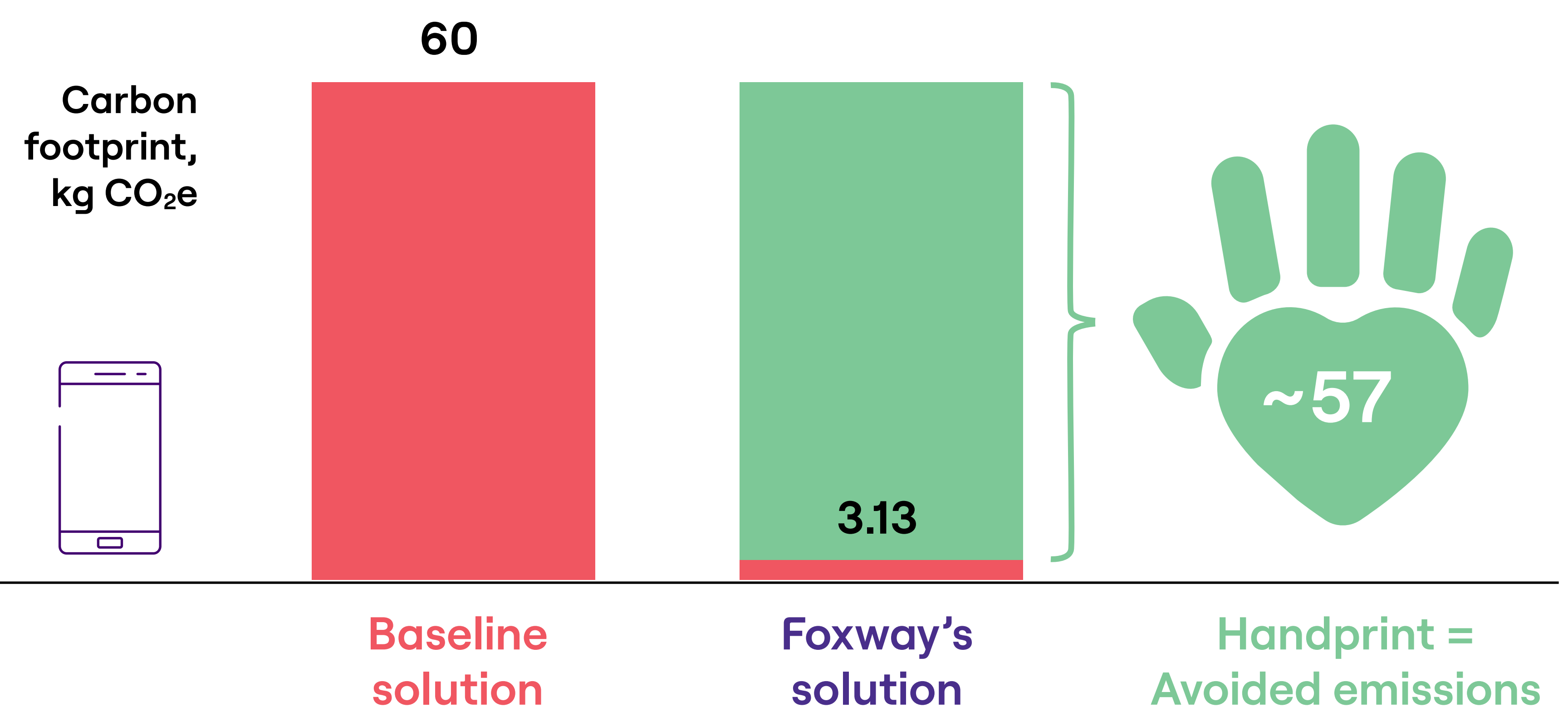
...3.13 kg CO_2e emissions for Android (or other) smartphones

The Carbon Handprint of one refurbished laptop



In other words, by buying a refurbished Apple smartphone from Foxway instead of purchasing a brand new mobile, a customer will avoid ca 58 kg CO_2e worth of emissions.

Buying a refurbished Android (or other) smartphone from Foxway instead of purchasing a brand new mobile, a customer will avoid ca 57 kg CO_2e worth of emissions.



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