

Comparative sustainability report: Fairphone 5, Samsung A54 and iPhone SE

This report was drawn up by John Watt of Ecoscope SL on behalf of the Environment Department of the Flemish government.

Calculations in this report are based on LCA-data by the producers. This quick exercise was made in light of an internal decision making process. Do not use this document to compare offers in a procurement process. See a.o. the [LCC tools developed by the European Commission](#) for tools to use in a comparison.

The tabs of the Excel accompanying this report are protected. Only adapting assumptions, phones and phone LCA / price data is possible without lifting the protection. There is no password for the Excel. The protection can easily be lifted to adapt the Excel further to your needs. Adapt the Excel, experiment and share your experience!

Introduction

This report aims to support the Government of Flanders' Department of Environment and Spatial Development (DOMG¹) in evaluating the environmental advantages of introducing Fairphone 5 as the default Android phone for employees. To make good decisions, DOMG specifically requested more information on the Total Cost of Ownership (TCO) and the CO₂-equivalent emissions linked to Fairphone 5 and the phones currently in use: Samsung A54 and Apple iPhone SE 64 GB.

As most environmental impact can be won by lengthening the lifetime of smartphones, the report also looks into device longevity, reparability and certifications.

Total Cost of Ownership (TCO) and CO₂

Below, this report describes both the data used and assumptions made to calculate the Total Cost of Ownership (TCO) and Carbon impact per device per year.

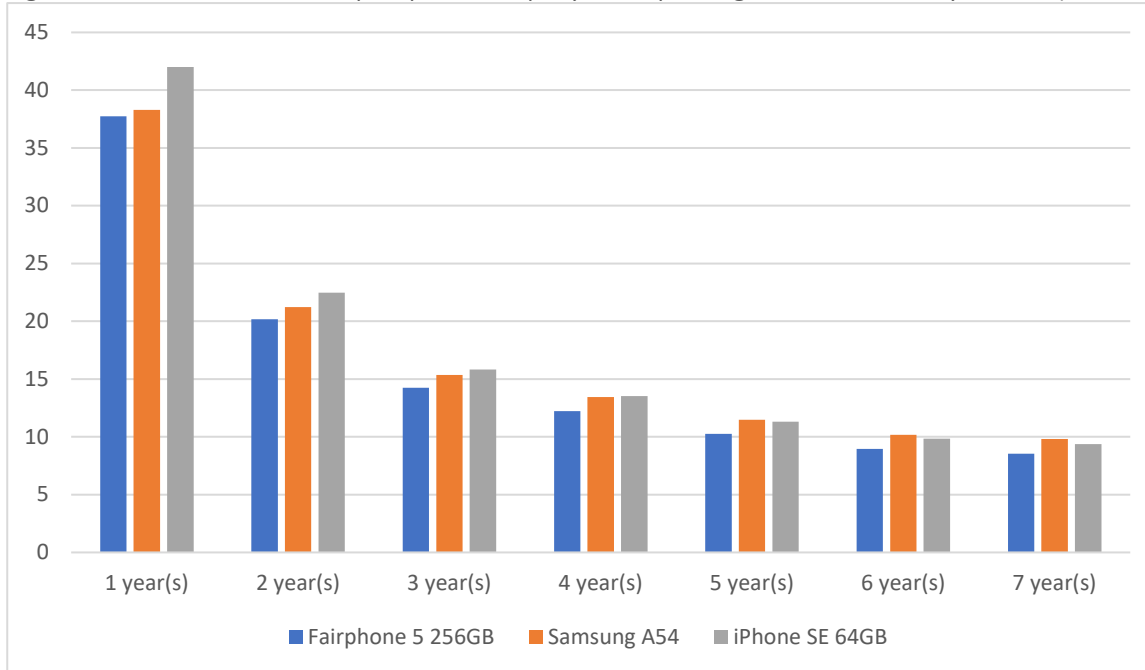
Table 1: TCO (green column heading) and Carbon impact (blue column heading) per device per year

Number of years use (ambition) ²	Fairphone 5 256GB	Samsung A54	iPhone SE	Fairphone 5	Samsung A54	iPhone SE 64GB
1 year(s)	€ 715,15	€ 441,90	€ 474,32	37,74	38,30	42,01
2 year(s)	€ 367,57	€ 247,31	€ 263,52	20,18	21,22	22,49
3 year(s)	€ 248,38	€ 173,66	€ 184,47	14,26	15,37	15,82
4 year(s)	€ 198,77	€ 155,59	€ 164,69	12,22	13,45	13,52
5 year(s)	€ 161,02	€ 129,74	€ 137,03	10,26	11,49	11,31
6 year(s)	€ 135,85	€ 112,51	€ 118,58	8,95	10,19	9,84
7 year(s)	€ 123,57	€ 110,92	€ 116,69	8,54	9,83	9,38

¹ Departement Omgeving

² This report doesn't take into account a second lifetime in other organizations. The lifespan of the devices is assumed to be (the ambition for) the number of years each device is used before replacement.

Figure 1: Overview of Carbon impact per device per year, depending on the number of years use (ambition)



Costs

Some insight is necessary to know the total cost of ownership. DOMG buys and maintains smartphones and has no intention of researching ‘anything as-a-service’ (XaaS) options (e.g. lease). Therefore, this report investigates the devices’ acquisition costs (purchase prices) and the costs for the most common repairs.

The energy cost was not considered as the electricity use, and thus costs, for charging a smartphone are very low³:

- Fairphone 4: 3905mAh battery, 3.3 kWh annual consumption⁴
- Fairphone 5: currently unknown
- Samsung A54: 5000mAh battery, 4.2 kWh annual consumption⁵
- Apple iPhone SE: Estimated 1.621 kWh to 3.5 kWh annual consumption⁶

As highlighted in a 2021 study⁷, the most common smartphone repairs include display, battery, and back cover issues. These components are frequently affected by technical failures and breakages, which can lead to early replacement. The study also discusses the importance of design in enhancing both the reliability and reparability of these devices to extend their functional lifespan.

In light of this study, the costs of replacing the display module and the battery were taken into account. Although the 2021 study found back cover issues to be in the top 3 of most common repairs, this type of repair isn’t considered in the calculations for this report, as people do not replace a back screen as quickly as they would replace the display. In this light, it is important to highlight that Fairphone 5 has a plastic back cover, which traditionally is less fragile to cracks than the glass back covers of the Samsung A54 and iPhone SE 3rd generation. A (mandatory) additional protective back

³ A quick study VRT NWS has made in 2023, shows a number of €2.7/year (situation march 2023). See <https://www.vrt.be/vrtnws/nl/2022/09/27/energiekost-huishoudtoestellen/>.

⁴ <https://www.visermark.com/smartphone-ranking>

⁵ <https://www.visermark.com/post/samsung-galaxy-a54-smartphone-battery-performance#:~:text=How%20power%20efficient%20is%20the,the%20Samsung%20Galaxy%20A34.>

⁶ Sourced from a “[Teardown](#)”: Apple does not provide data beyond an annual iPhone average energy consumption of [3.5 kWh/annum](#).

⁷ See Cordella M, Alfieri F, Clemm C, Berwald A. Durability of smartphones: A technical analysis of reliability and reparability aspects. J Clean Prod. 2021 Mar 1;286:125388. doi: 10.1016/j.jclepro.2020.125388. PMID: 33658746; PMCID: PMC7871336.

cover can be essential in keeping a (glass) back cover safe – almost 75% of all front and back glass display damages are due to drops on corners or edges.⁸

The table below also shows costs other than replacing the display module and battery replacement. These costs are provided for information purposes only.

Table 2: Overview of common costs (VAT included)

Component	Fairphone 5 Cost	Samsung A54 Cost	iPhone SE Cost
Full device	€715.11 ⁹	€441,90 ⁹	€474,32 ⁹
Display Module (Screen repair)	€99.95 (Fairphone – self replace)	€263,63 (VDAB – parts and service)	€263,63 (VDAB – parts and service)
Battery	€39.95	€75 ¹⁰	€79 ¹¹
USB Connector Module	€19.95	€20 (indication – not on Samsung website)	Not available on Apple website
Rear Cameras Module	€69.95	€56 (indication – not on Samsung website)	Not available on Apple website
Loudspeaker Module	€24.95	€14 (indication – not on Samsung website)	Not available on Apple website
Back Cover	€24.95	€34 (indication – not on Samsung website)	€169 (indication - Not available on Apple website) ¹²

For repairs/replacement of components, the following assumptions were made:

- Screen repairs: 10% of phones per year.
The numbers for screen repairs in literature are quite high, e.g. 30% per year¹³. However, this isn't in line with the experiences of the DOMG IT team. The IT teams of OVAM and VDAB received the same signal. Users might accept some cracks in the screen or protect their smartphones quite well. Good data from DOMG is, however, lacking. 10% of screen repairs was seen as a fair assumption.
- Battery replacements: one replacement every 3 years, except when the smartphone is due for replacement itself.
The lifespan of a battery before the capacity drops below 80% is 500 charge cycles. This equals a typical lifespan of 2-3 years, although a battery can still be used at less capacity after this time. However, changing a battery when the smartphone is due to be replaced is not cost-effective. Therefore, the assumption is that one battery replacement will occur when the use time ambition is 4, 5 or 6 years, and two battery replacements will occur when the use time ambition is set for 7 years.

⁸ Schischke K., Moraza D., Rottner S., Galley J. Disassembly Studies. Deliverable of the EU H2020 sustainablySMART project. 2017. <https://www.sustainably-smart.eu/app/download/9094936482/DisassemblyStudies.pdf?t=1548940654>

⁹ Framework agreement 2022/HFB/OP/93534 with Dustin (including best price guarantee) - Price on 25/06/2024

¹⁰ Based on US price of \$80, inclusive of labour/service costs: <https://www.samsung.com/sg/support/mobile-devices/galaxy-phone-battery-replacement-pricing/>

¹¹ Apple will "check your service coverage to determine the final service fee": <https://support.apple.com/en-ie/iphone/repair/battery-replacement>

¹² Taking into account the cheapest option mentioned in '[Apple made it way cheaper to repair an iPhone 15 Pro's broken back glass](#)' – There is no specific information on iPhone SE.

¹³ E.g. '[Cell Phone Repair 2023 Statistics and Trends](#)', 2023: "66% of consumers damaged their devices in the past year, with 30% having a cracked phone screen during the study period." – This means about 19% of screens (30% of 66%) were cracked in 2023.

Lifecycle impact

Lifecycle impact of the device

To calculate the CO₂-equivalent emissions for a device, you need to have an overview of the carbon impact of the devices in every stage of their lives.

The life cycle analyses (LCA) information used for this report is calculated over a 3-year period for all phones¹⁴. This resulted in the following Carbon impact information:

Total Carbon impact over 3 years:

- Fairphone 5: 42.14 kg CO₂-e (Source: [Fairphone 2023 Impact Report](#))
- Samsung A54: 49.2 kg CO₂-e (Source: [Samsung LCA reports](#))
- Apple iPhone SE 64GB model: 46 kg CO₂-e (Source: [Apple Product Environmental Report – iPhone SE \(3rd generation\)](#))

Table 3: CO₂ emissions

	Fairphone 5	Samsung A54	iPhone SE 64GB
CO ₂ emissions (%) – Production	77.60%	68.89%	82.00%
CO ₂ emissions (%) – Transport	6.60%	3.46%	4.00%
CO ₂ emissions (%) – Use ¹⁵	15.70%	27.24%	13.00%
CO ₂ emissions (%) – End-of-Life ¹⁶	0.10%	0.41%	1.00%
CO ₂ emissions (kg) – Production	32.7	33.9	37.72
CO ₂ emissions (kg) – Transport	2.8	1.7	1.84
CO ₂ emissions (kg) – Use ¹⁵	6.6	13.4	5.98
CO ₂ emissions (kg) – End-of-Life ¹⁴	0.04	0.2	0.46

Source from OEMs own data. Caution! Calculation methodologies differ from one manufacturer to another.

Carbon impact of the components

The longer the lifetime of a device, the bigger the chances that components need to be replaced. Those new components have a Carbon impact of their own. The data available is limited. Therefore, this report needs to make assumptions about the carbon impact of the Samsung A54 and iPhone SE.

Batteries

Specific data for Samsung and Apple batteries is unavailable and/or unreliable. Using other sources in Table 4, an assumption can be made that a battery can be approx 9% of the LCA.

Table 4: References on the Carbon impact of batteries

Model	kg CO ₂ e	Source
Nexus 4	7.5	UC San Diego ¹⁷
Fairphone 5	3.7	Fairphone 2023 Impact Report
iPhone SE	1.38	Green alliance – Batteries = 3% embodied carbon ¹⁸
Samsung A54	1.34	Green alliance – Batteries = 3% embodied carbon ¹⁸
iPhone SE	6.90	UC San Diego – Battery = 15% embodied carbon ¹⁷

¹⁴ The Fairphone 5 and Samsung A54 LCA explicitly states a system boundary of 3 years. Apple mentions in the Environmental Report 3 or 4 years for the use phase. In its [2020 Environmental Progress Report](#) Apple more clearly states that it assumes “three years for iOS devices”.

¹⁵ Use phase is based on 3 years of use

¹⁶ Fairphone ensures the Fairphone 5 is e-waste neutral. For every device sold, Fairphone recycles at least one phone, regardless of the sales channel.

¹⁷ Junkyard Computing: Repurposing Discarded Smartphones to Minimize Carbon, UC San Diego

¹⁸ Green alliance, A circular economy for smart devices – Opportunities in the US, UK and India, 2015

Samsung A54	6.71	UC San Diego – Battery = 15% embodied carbon ¹⁷
iPhone SE	4.14	Average of 2 studies above = 9% of total LCA
Samsung A54	4.02	Average of 2 studies above = 9% of total LCA

The 15% figure from the UC San Diego study seems more plausible, given that the Nexus 4 study showed a similar figure. However, the average of the two studies also brings it to just above Fairphone, which could also be a fair assumption. As this is a fair assumption, this average is the % taken into account for the calculations made in this report.

Screens/displays

Specific data for Samsung and Apple screens is unavailable and/or unreliable. Using other sources in the table below, an assumption can be made that a screen can be approximately 10.5% of the LCA.

Table 5: References on the Carbon impact of screens/displays

Model	kg CO ₂ e	Source
Nexus 4	5	UC San Diego
Fairphone 4	2.11	Fraunhofer – Display = 5% ¹⁹
iPhone SE	5.06	Green Alliance - Display = 11% embodied carbon
Samsung A54	4.92	Green Alliance - Display = 11% embodied carbon
iPhone SE	4.60	UC San Diego – Display = 10% carbon
Samsung A54	4.47	UC San Diego – Display = 10% carbon
iPhone SE	4.83	Average of 2 studies above = 10.5% of total LCA
Samsung A54	4.69	Average of 2 studies above = 10.5% of total LCA

The average figure of the two screen studies is around the figure of the Nexus - so this % was used in the calculations as a fair assumption.

Use longer

‘Use longer’ is one of the four core strategies in [the framework for the Circular and Fair ICT Pact \(CFIT\)](#), a pact signed by the policy domain to which DOMG belongs. As the most Carbon impact of smartphones lies in the production stage (see Table 3), much Carbon impact can be avoided by using the devices longer. A repairable/upgradeable design, availability and cost of spare parts, guaranteed software updates and warranties help users use devices longer.

Carbon impact of using longer

The [Fairphone 2023 Impact Report](#) states that the use extension from 3 to 5 years reduces the CO₂ footprint by 28% and to 7 years by 46%. These reductions are consistent with the calculations made in this report when extending the lifetime from 3 to 5 years, based on the LCA data and assumptions on battery replacement and screen repair. For an extension of up to 7 years, this report finds a reduction of the annual footprint by 40%. This can, for example, be explained by the difference in the number of battery replacements.

No reliable data on Samsung and iPhone were found. The calculations made in this report show similar results as for Fairphone 5. For Samsung 54A, the use extension to 5 years reduces CO₂ footprint by 25% and to 7 years by 36%. For the iPhone SE, the use extension to 5 years reduces CO₂ footprint by 27% and to 7 years by 40%.

¹⁹ More detailed information on the carbon impact of the Fairphone 4 can be found in the [‘Life cycle assessment of the Fairphone 4’](#), Fraunhofer, 2022
26 November 2024

To extend the lifetime, it's essential that DOMG chooses smartphones with a high potential for a longer use time and sets up the necessary measures to ensure the use time set out in the department's ambitions. Apart from using the devices longer within the department, a second life in another organization is a possible route to lower the carbon impact of the smartphones further.

Potential for a longer use time

Repairability, upgradability and software updates

	French repairability index	iFixit	Software updates
Fairphone 5	9.3	10/10	8 years , until 2031, covering at least the next 5 versions of Android (Source: Fairphone)
Samsung A54	8.4 ²⁰	No score	3 years of Android OS updates & 4 years of security patches commitment for some devices. ²¹
Apple iPhone SE	6.4	6/10 ²²	5 years of iOS updates after the release of the device (2022). ²³

Warranties

Warranties don't always mean that a provider will repair the phone. However, a more extended warranty period triggers bidders to offer smartphones with higher durability and repairability.

Currently, the following warranties apply:

- Fairphone 5 = [5 years](#) (standard Fairphone warranty)
- iPhone SE = 1 year²⁴
- Samsung A54 = 1 year²⁴

Certifications and standards

Some certifications and standards, such as TCO Certified and EPEAT, hold requirements on design and the availability of spare parts. The following certifications can be found:

- Fairphone 5: TCO Certified, Fairtrade Gold²⁵, [Eco Rating 74/100](#).
- Samsung A54: EPEAT Gold.
- Apple iPhone SE: 2nd Gen (2020) was EPEAT Gold, but no registration for 3rd Gen (2022).

²⁰ Samsung's mid-rangers are ever so slightly more repairable than its flagships, at least when it comes to the French criteria.

²¹ <https://www.androidpolice.com/samsung-four-year-update-list-android/>

²² For the 2020 Edition of the SE

²³ <https://www.coolblue.nl/en/advice/how-long-will-your-refurbished-iphone-still-receive-ios-updates.html> - Once a device is vintage or obsolete, it no longer receives updates.

²⁴ Minimum warranty period as foreseen in the Framework agreement 2022/HFB/OP/93534 with Dustin

²⁵ <https://www.fairtrade.net/standard/gold/> / <https://www.fairphone.com/nl/2021/11/30/fairtrade-hirose/>

Ambitions for a longer use time

The estimated current use time of devices, as reported by the IT team of DOMG, is:

- Samsung A54: 3.18 years
- Apple iPhone SE: 3.85 years

At the time of this report, DOMG still had to decide whether to replace all Samsungs with Fairphones or if they would aim for a transition period in which users could still choose between Samsung or Fairphone (if they choose an Android phone).

In light of this report, the following ambitions are set:

- Fairphone 5: At least 5 years of use time
- Samsung A54: At least 3 years of use time
- iPhone SE: At least 4 years of use time

Table 6: TCO and carbon impact per device per year, taking into account use time ambitions of DOMG

Name of phone	Number of years use (ambition)	Cost/year	CO ₂ (kg)/year
Fairphone 5 256GB	5 year(s)	€ 161,02	10,26
Samsung A54	3 year(s)	€ 173,66	15,37
iPhone SE 64GB	4 year(s)	€ 164,69	13,52

DOMG has about 516 Android devices in use. Switching them over the next 3 years to Fairphone, accompanied by the necessary measures to use these devices for 5 years, will save €6.526,27 per year and 2.637,45kg CO₂/year.

This report is accompanied by an Excel calculation sheet, which DOMG can easily use to recalculate other scenarios, e.g. different ambitions in use time or accounting for protective cases and screen protectors on the necessary screen replacement²⁶.

Conclusion

When comparing the phones, considering the ambitions of the lifetime that the DOMG has set, the Fairphone 5 offers the lowest cost per year and promotes environmental sustainability with a slightly lower CO₂ emission rate annually compared to the other models.

However, initial purchase costs are higher than those of the Samsung A54, but they offer a longer lifespan, which amortizes the costs over more years. The iPhone SE 64GB has a moderate initial cost and lifespan but has the highest screen replacement cost, impacting its annual TCO.

Fairphone 5 emerges as the most cost-effective option over time, thanks to its emphasis on sustainability and self-repairability using lower-cost modular parts. The moderate increase in total cost over time is a testament to its design, which allows for more accessible and less expensive repairs.

The software longevity of the Fairphone 5 must also be considered, making it more likely to reach 5+ years of use compared to Apple and Samsung devices.

²⁶ [Smartphone Repair Study 2019](#) by Click Repair holds useful information on the effect of protective cases and screen protectors on screen damage.