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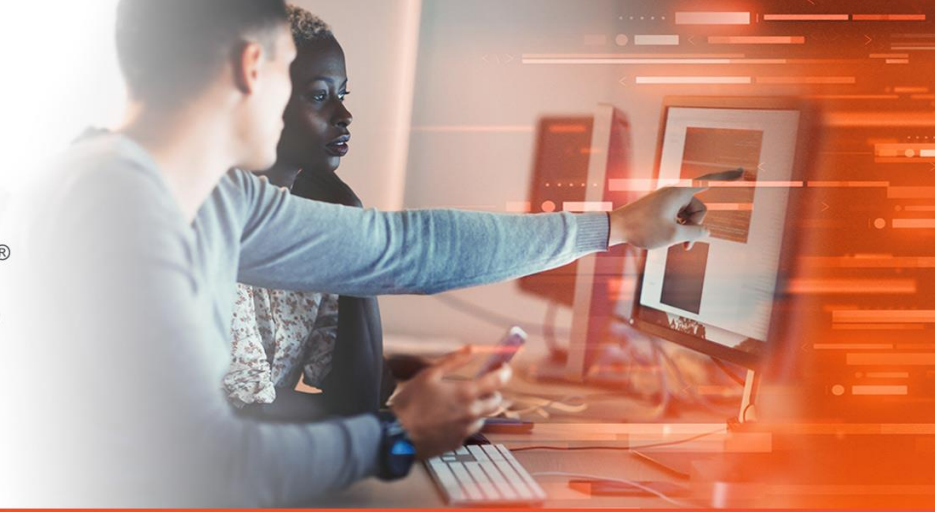
SOFTWARE-DEFINED
EVERYTHING



GREEN SOFTWARE: THE KEY TO ENVIRONMENTALLY-FRIENDLY SOFTWARE DESIGN

OPTIMIZE YOUR IOT DEVICES FOR ENVIRONMENTAL SUSTAINABILITY AND COST-EFFICIENCY

While the information and communication sectors are commended for facilitating efficiencies that reduce the carbon footprint of other industries, they have often been overlooked as notable contributors to global greenhouse gas emissions.

Addressing this challenge, embedded veteran expert Jacob Beningo highlights how the excessive memory and processing power of IoT devices are driven by the push for complexity and future-proofing, leading to suboptimal energy usage and resource waste.

As processors continue to decrease in cost, it has become commonplace to opt for larger, more powerful processors as a precautionary measure. However, a recent study reveals that despite significant efforts to enhance energy efficiency in computing over the last two decades, the primary contributor to overall carbon emissions has shifted from operational activities to hardware manufacturing and system infrastructure.

To reverse this trend, MicroEJ's optimized software containers offer an effective alternative to high-level operating systems that cannot run on lower-cost processors, drastically reducing resource usage. By adopting software containers, carbon emissions and production costs are lowered, enabling optimal hardware utilization and promoting sustainability. Furthermore, MicroEJ provides partial software updates that extend product life and increase overall efficiency, leading to environmental and cost savings.

MicroEJ makes it possible to prioritize simplicity and energy efficiency in IoT designs, two essential ingredients for achieving sustainability goals, ultimately benefiting businesses and consumers in the long term.

GREENLY STUDY ON AVOIDED CARBON EMISSIONS

To assess the potential reduction in carbon emissions, MicroEJ commissioned Greenly, a leading carbon footprint platform, to thoroughly investigate the impact of electronic design on the carbon footprint of IoT devices.

The study carefully compared two smart sports watches, with a specific emphasis on fitness usage. We intentionally excluded functions unrelated to sports and wellness to ensure a fair and meaningful comparison and maintain a strict "apples-to-apples" approach.

The results clearly demonstrate that embracing lightweight software solutions enables the integration of low-power electronic components, resulting in a substantial reduction in emissions throughout the entire device life cycle.

A fully detailed description of sources and methodology is included in the Appendix section at the end of the document.

METHODOLOGY

The correlation between power consumption avoidance and the adoption of lower power and cost-efficient hardware is pivotal in achieving environmental sustainability, made possible through the implementation of low-footprint software.

To thoroughly investigate this hypothesis, Greenly conducted a comprehensive comparison of carbon emissions between two comparable fitness watches:

- The Polar Pacer Pro powered by MicroEJ
- The Samsung Galaxy Watch 5 powered by WearOS

The assessment of production emissions focused specifically on the components directly impacted by the efficiency of the MicroEJ software solution. This approach emphasizes emissions directly avoided due to the software's performance, rather than emissions reduced through specific frugal choices that may vary based on user preferences, such as the presence or absence of a touchscreen.

By leveraging basic calculations, Greenly aggregated the resulting difference in carbon emissions, revealing the cumulative carbon emissions avoided for 1 million units.

This study provides crucial insights into the tangible environmental benefits achieved through the adoption of low-footprint software in IoT devices.

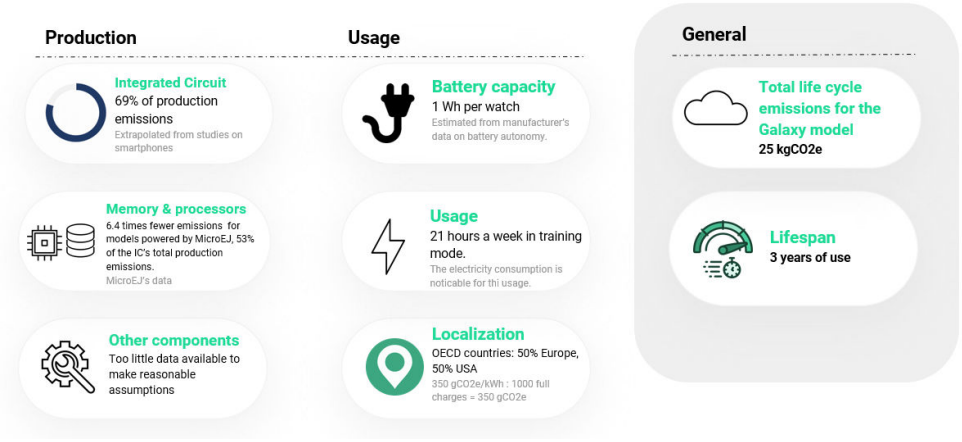


FIGURE 1: STUDY PARAMETERS AND HYPOTHESIS FOR THE FITNESS WATCH

RESULTS

Greenly's findings underscore the profound impact of embracing low-footprint software solutions in IoT devices.

Given the considerable carbon footprint of a smartwatch's processor and battery, the resulting savings are significant. Software design efficiency implies involves significantly reducing resource usage by optimizing code size.

Adopting the tiny MICROEJ VEE software containers leads to a remarkable 34% reduction in emissions between the two smartwatches.

By facilitating the use of a smaller and less powerful processor than Android, MICROEJ VEE minimizes the need for power-hungry electronic components and enables the use of a smaller battery.

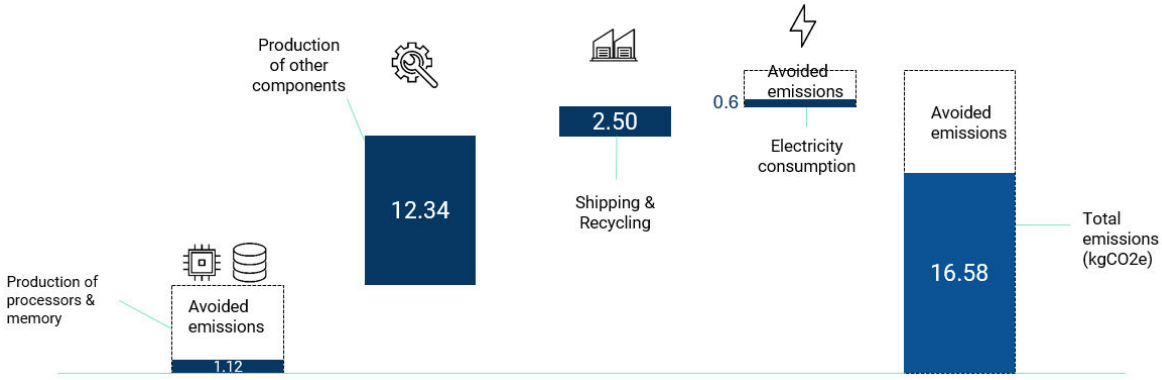
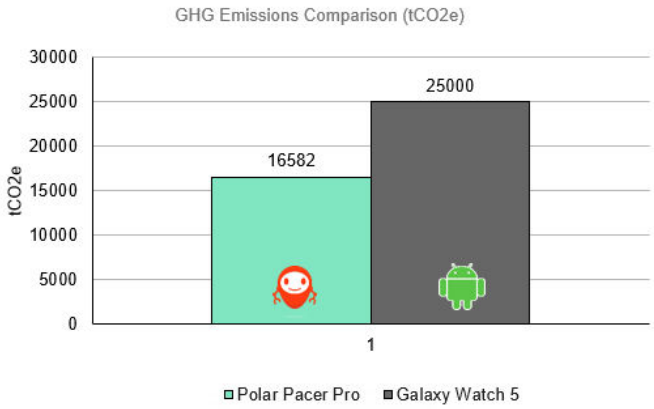
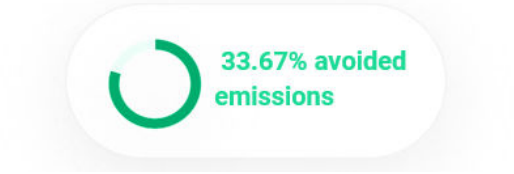


FIGURE 2: CARBON REDUCTION FOR THE SPORT WATCH BASED ON MICROEJ VEE COMPARED TO SIMILAR SOLUTION

Impact per scenario model for 1 million products sold, with a 3-year lifespan.





The difference between both scenarios is equal to 8438 tons of CO2e.

Which is equivalent to :

- Emissions induced by 6750 return trips from Paris to New York
- The annual emissions of 602 US households
- The volume of CO2 sequestered by 3621 hectares of forest

FIGURE 3: IMPACT FOR 1 MILLION UNITS FOR THE SPORT WATCH

CONCLUSION:

This study presents a compelling case for the industry, emphasizing the substantial carbon savings achievable through the adoption of low-footprint software without compromising software design efficiency. Embracing this approach empowers manufacturers to make environmentally responsible hardware choices, guiding us toward a greener and more sustainable future while addressing the costs and opportunities associated with carbon emissions. Despite the study's limited scope, excluding functions such as network usage, its estimations remain significant, highlighting the critical role of hardware component selection in designing eco-friendly electronic devices.

The burgeoning growth of IoT necessitates a transformative approach. Prioritizing low-footprint software is now imperative, not optional, as it not only reduces carbon emissions but also fosters more profitable innovations. Let us unite to advocate for green software and promote sustainability for a better world.

APPENDIX

DETAILED METHODOLOGY

Greenly's methodology for comparing carbon emissions employs a conservative approach that emphasizes accuracy and reliance on published data. The methodology applied as in follow:

1 – Importance of Integrated Circuit (IC) in global emissions calculation

Greenly used a published paper on smartphone emissions as a starting point to determine the carbon emissions attributed to the integrated circuit, including the processor and memory. According to the paper, device's production-related carbon emissions were estimated at 47.9 kg CO2e/3 years, with the IC contributing 69% of the production carbon footprint.

2 – Findings for production contribution

Acknowledging the differences in carbon emissions between production, shipment, service, and power consumption during use, Greenly referenced a Lifecycle analysis study on an Android-powered smartwatch. The study indicated that 78% of emissions stem from the production phase, for a total of 25 kg CO2e over 3 years of use.

3 – Impact of IC on carbon emissions calculations in a smartwatch

Building on the above data, Greenly calculated the IC accounts for 69% of production phase emissions.

4 – Assumption based on BoM costs

Greenly based the study on the costs of processors and batteries found in the device's bill of materials.

This method offers simplicity and requires minimal input data, enabling better control of uncertainty. However, it has limitations, relying on monetary factors and estimations from smartphone studies, likely underestimating the actual avoided emissions due to assuming identical other electronic components in comparison scenarios.

To evaluate the combined costs of memory, processing, and power management for the Samsung Galaxy watch, Greenly used two Bill of Materials (BoM) cost analyses as a basis for its estimates, looking at the ratio for products using similar rich OS on powerful processors. The first analysis focused on the Apple Watch Series 6 BoM, where these components accounted for 48.1% of the total cost of integrated circuits. The second analysis was carried out for the Pixel Watch, resulting in a value of 58.5%. By considering both studies, we approximated that the processor, memory, and power management (PMIC) comprised around 53.3% of the integrated circuit costs, as well as associated CO2 emissions from integrated circuits.

5 - Calculating the Cost Difference in BoM between Polar Pacer Pro and Galaxy Watch to estimate the GHG emission reduction at production

Greenly took steps to determine the price difference between the processor and memory setups of the Polar Pacer Pro and the Galaxy Watch 5. It's important to highlight that the Galaxy Watch comes with a much more powerful processor (1.18GHz compared to 120 MHz) and a larger battery (284 mAh versus 255 mAh), which leads to a clear difference in the costs of their components.

To move forward with its analysis, Greenly first looked for information about the costs of materials for similar watches like the Pixel Watch and the Apple Watch Series 6, which cost around $123 and $136, respectively.

Afterward, Greenly calculated an approximate cost that included the Processor, Memory, and half the cost of the Power Management Integrated Circuit (PMIC) for these two benchmark smartwatches. These numbers were then averaged to estimate the cost of the components for the Galaxy Watch 5, which came out to be approximately $34.90.

For the Polar Pacer Pro, Greenly looked at a tear-down of the product, identifying the Microcontroller used and memory, and estimated that the actual cost of materials for a high-volume manufacturer would be roughly a quarter of the price of its public price through electronic low-volume distributors, which equals about $5.43.

Considering these details, the ratio used for calculations was the difference between these two values. This highlights that the Polar Pacer Pro processor plus battery combination is approximately 6.4 times less expensive compared to the Galaxy Watch.

6- Calculating the power consumption reduction to estimate the GHG emission reduction due to usage

Greenly then looked at the power figures from the Polar Pacer Pro and Galaxy Watch, based on published battery life in various scenarios and the battery capacity for each watch. Based on a realistic active sport scenario of 3 hours of sports activity per day, Greenly calculated a ratio of 4.97 in power consumption between the Galaxy Watch and the Polar Pacer Pro watch. Applying this ratio to the published usage GHG emission for the Pixel Watch as a proxy for the Galaxy watch gave the GHG emission reduction due to usage.

7- Calculating the total GHG emission reduction

Greenly computed the total GHG emission reduction by adding the GHG emission reduction from production and usage. The hypothesis was that transportation and end of life were the same in the two watch cases. Similarly, the difference between other IC components and mechanical and fashion components was considered nil regarding GHG emission. This hypothesis may underestimate the GHG emission reduction, as products that are more resource-intensive may also require more material for the other component (housing a bigger battery, for instance, or having a heavier product overall).

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ABOUT GREENLY

Founded in October 2019 by Alexis Normand (CEO, former VP of Healthcare at Withings, HEC, Sciences Po, formerly at the Boston offices of Withings and Techstars), Mathieu Vergeville (CTO, X-Telecom, former data scientist at Withings) and Arnaud Delubac (CMO, Essec-Centrale, INSEE, formerly in charge of digital communication in the office of the French Prime Minister), Offspend SAS launched Greenly in January 2020 as the world's first carbon accounting platform with almost 1,000 corporate clients in France, the UK and the US. The climate tech allows all enterprises, regardless of their size or sector of activity, to contribute to the fight against climate change, starting by simply tracking their CO2 emissions. Once a report is completed, Greenly helps them develop a roadmap to help them align themselves to a Net Zero Contributor Initiative. Greenly obtained the B-Corp label in September 2022, putting their solution at the disposal of society.

To learn more, visit: https://www.greenly.earth/

Certified:

ABOUT MICROEJ

MicroEJ (pronounced "micro-EDGE") is a software vendor of cost-driven solutions for embedded and IoT devices. We are focused on providing device manufacturers with secure products in markets where software applications require high performance, compact size, energy efficiency, and cost-effective development.

Today more than 120+ companies in the world with currently over 250 million products sold, have already chosen MicroEJ to design electronic product applications in a large variety of industries, including smart home, wearables, healthcare, industrial automation, retail, telecommunications, smart city, building automation, transportation, etc.

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