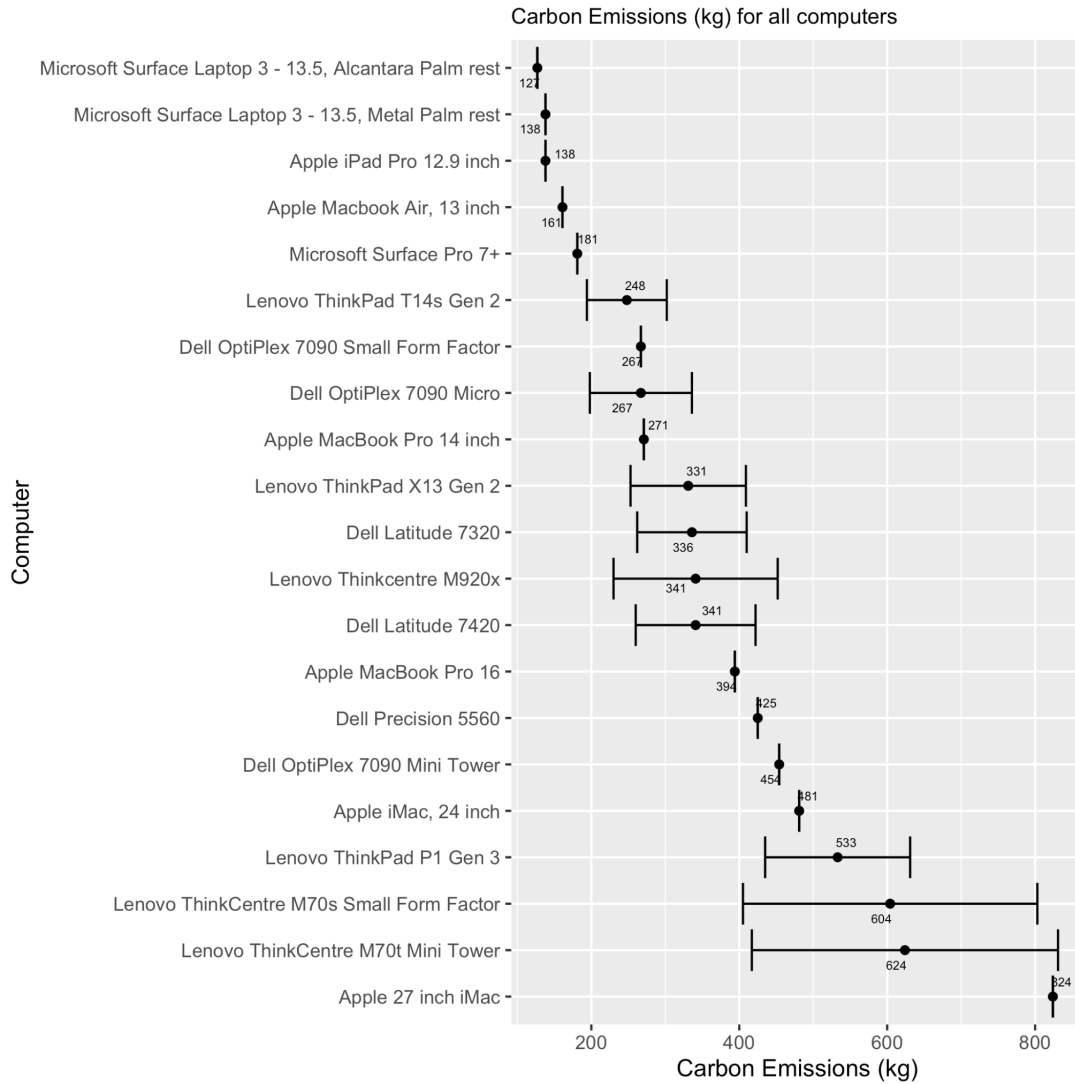
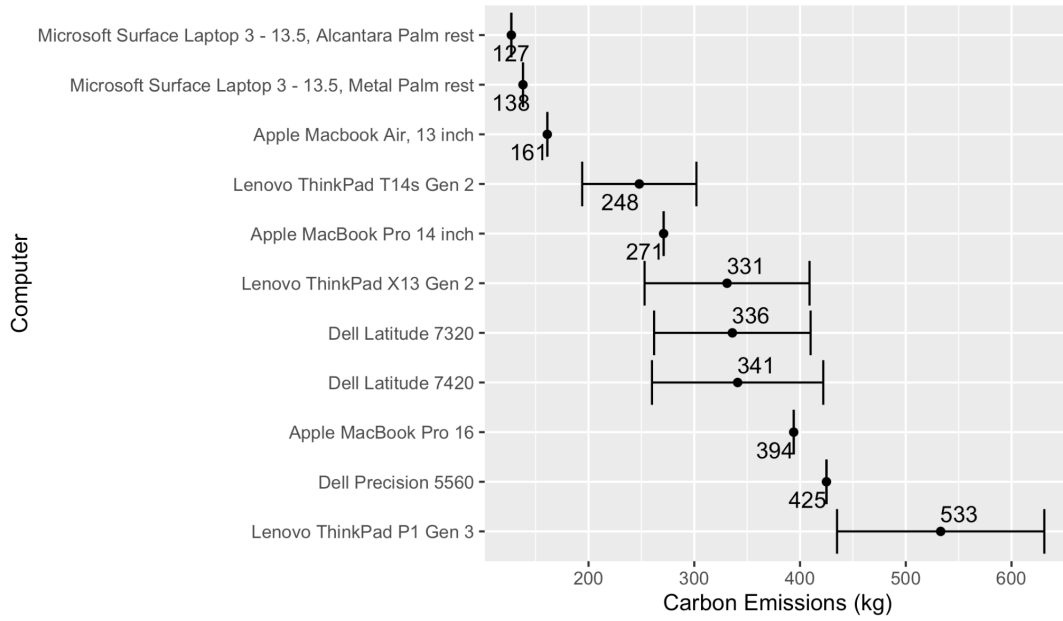


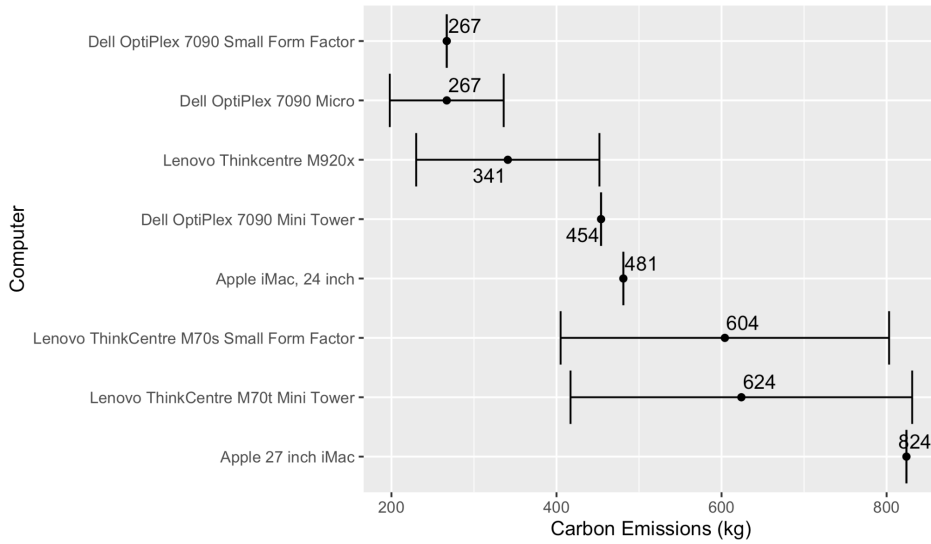
Note: Apple and Microsoft do not release confidence interval data for their devices, so in the following graphs, Apple and Microsoft devices do not have a confidence band, while Lenovo and Dell do.



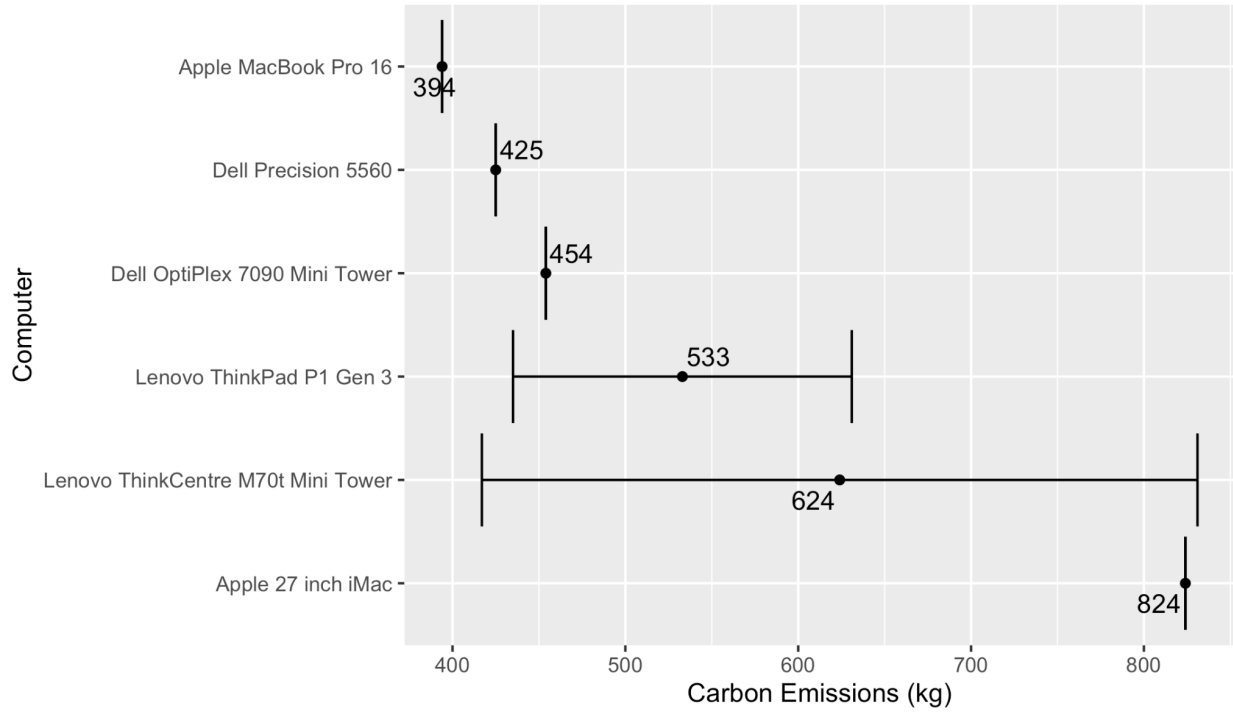
Carbon Emissions (kg) for Laptops



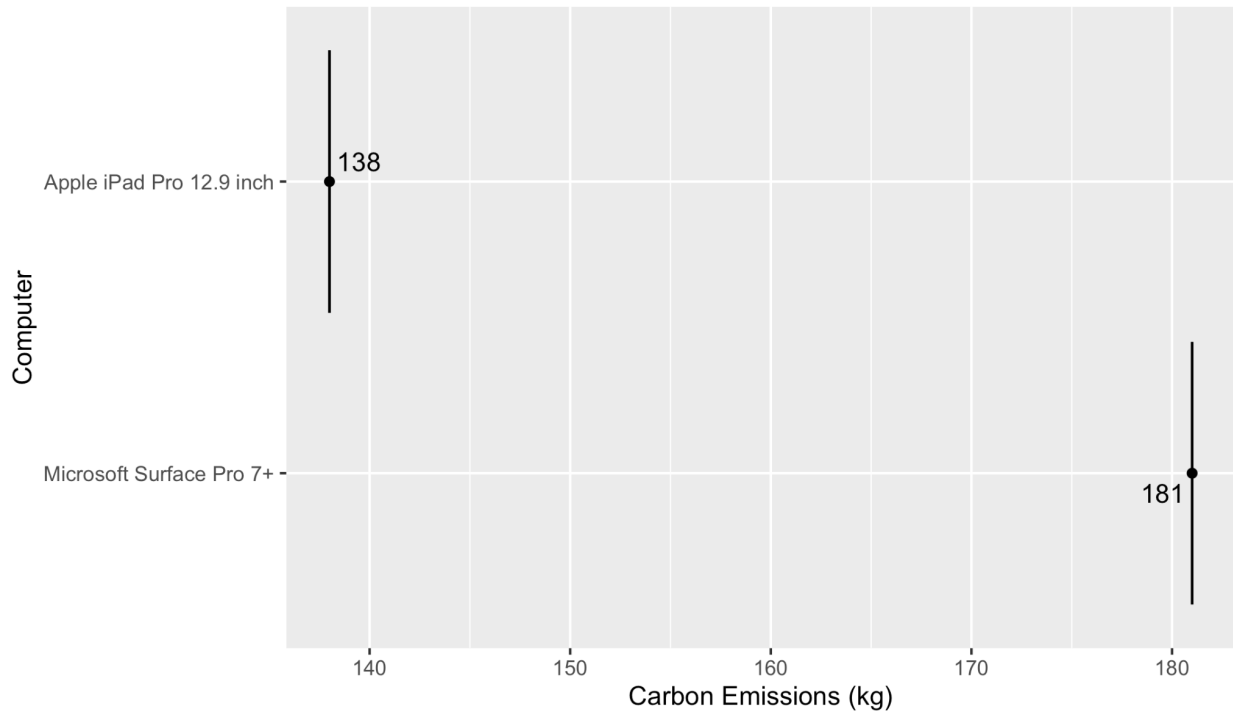
Carbon Emissions (kg) for Desktop Computers



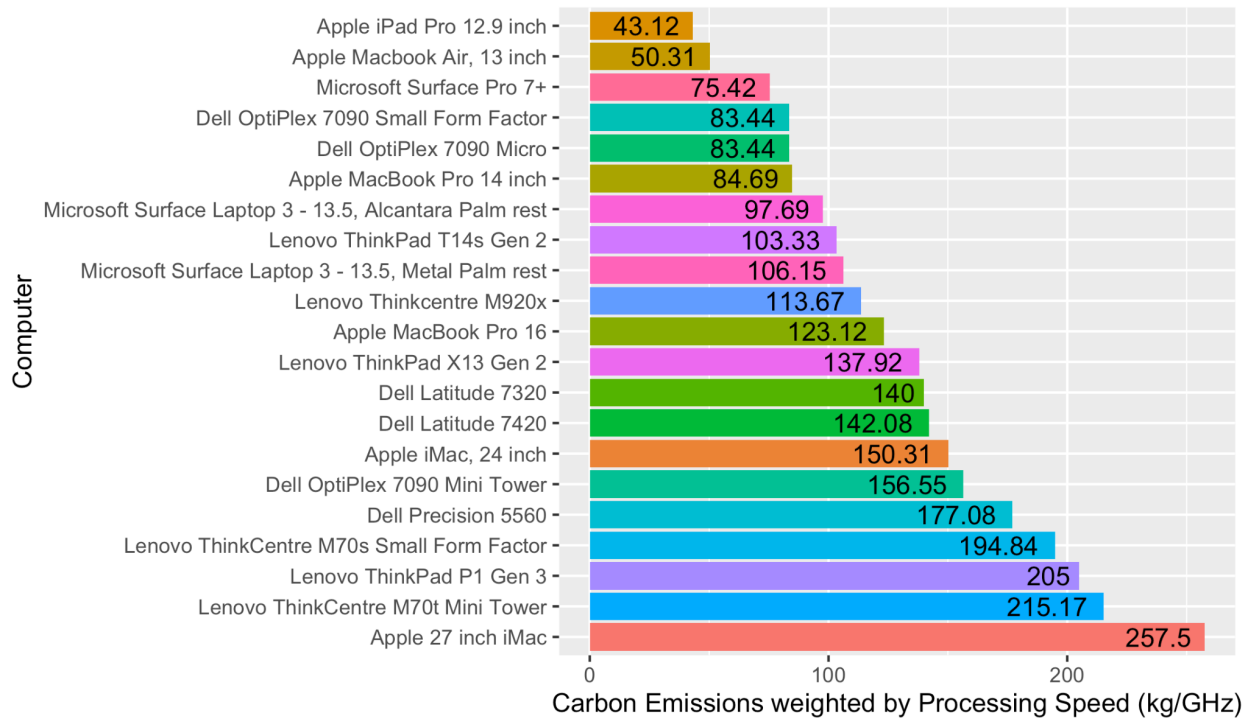
Carbon Emissions (kg) for Processor Intensive Computers



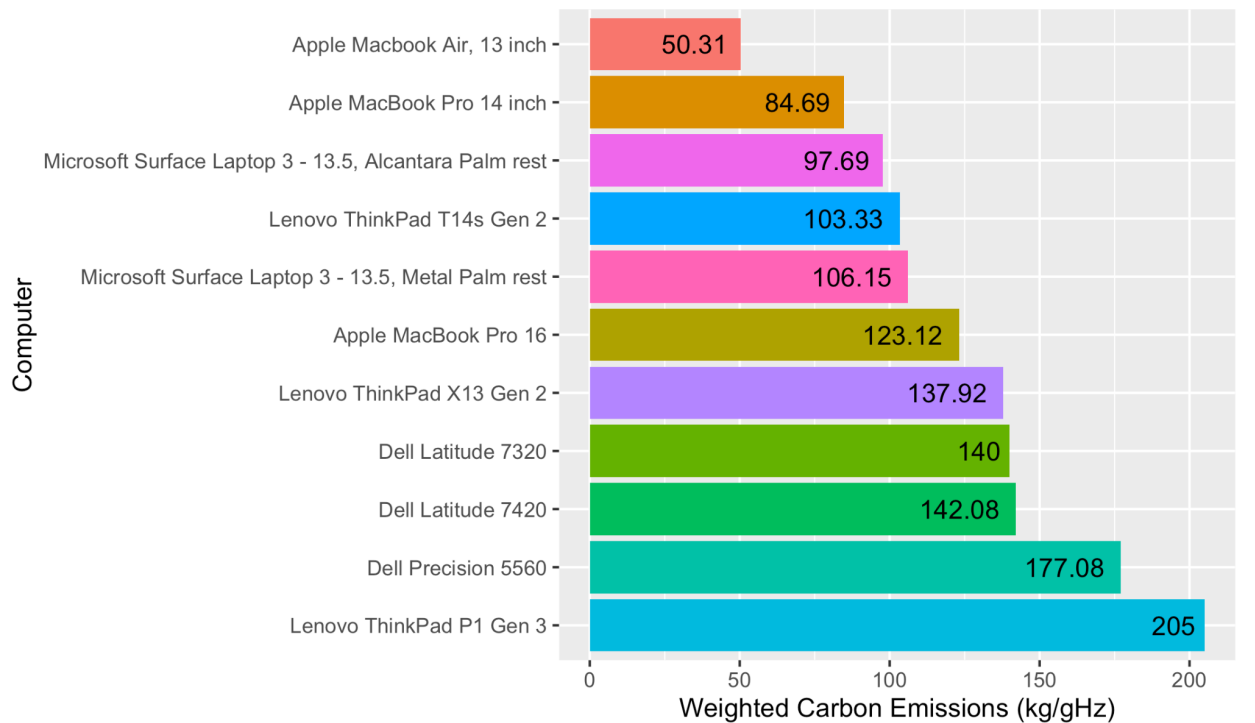
Carbon Emissions (kg) for Tablets



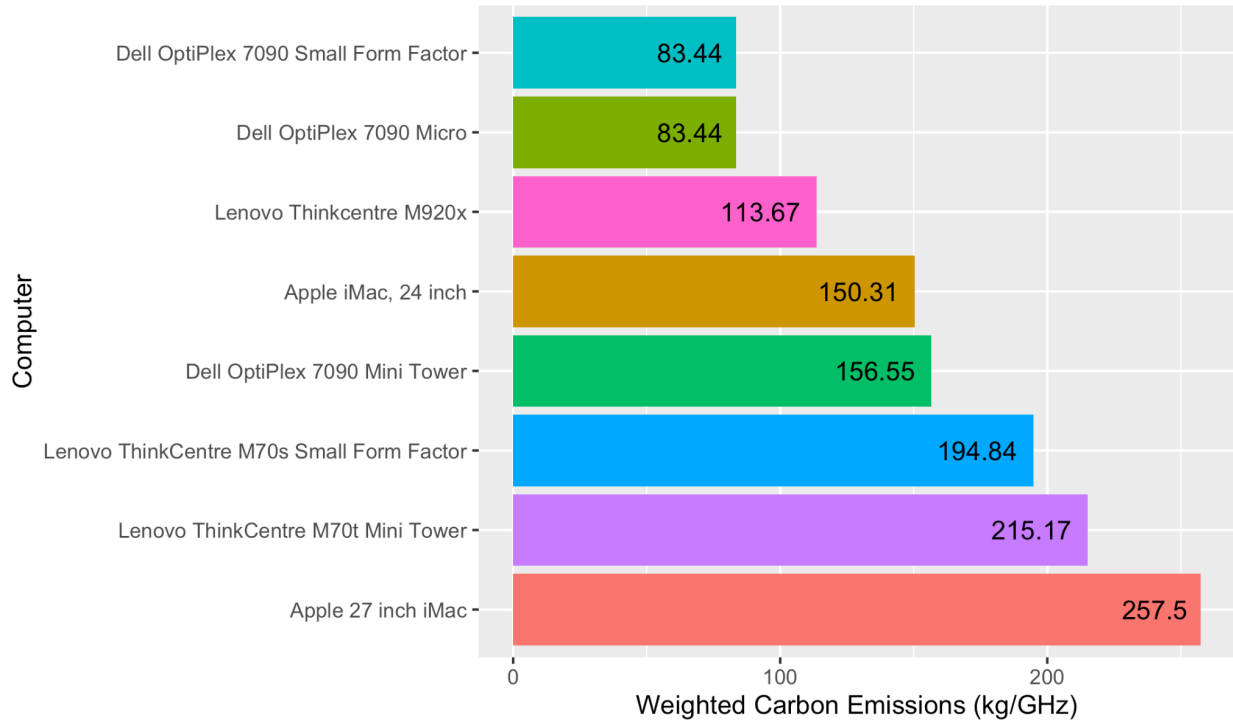
Weighted Carbon Emissions (kg/gHz) for all computers



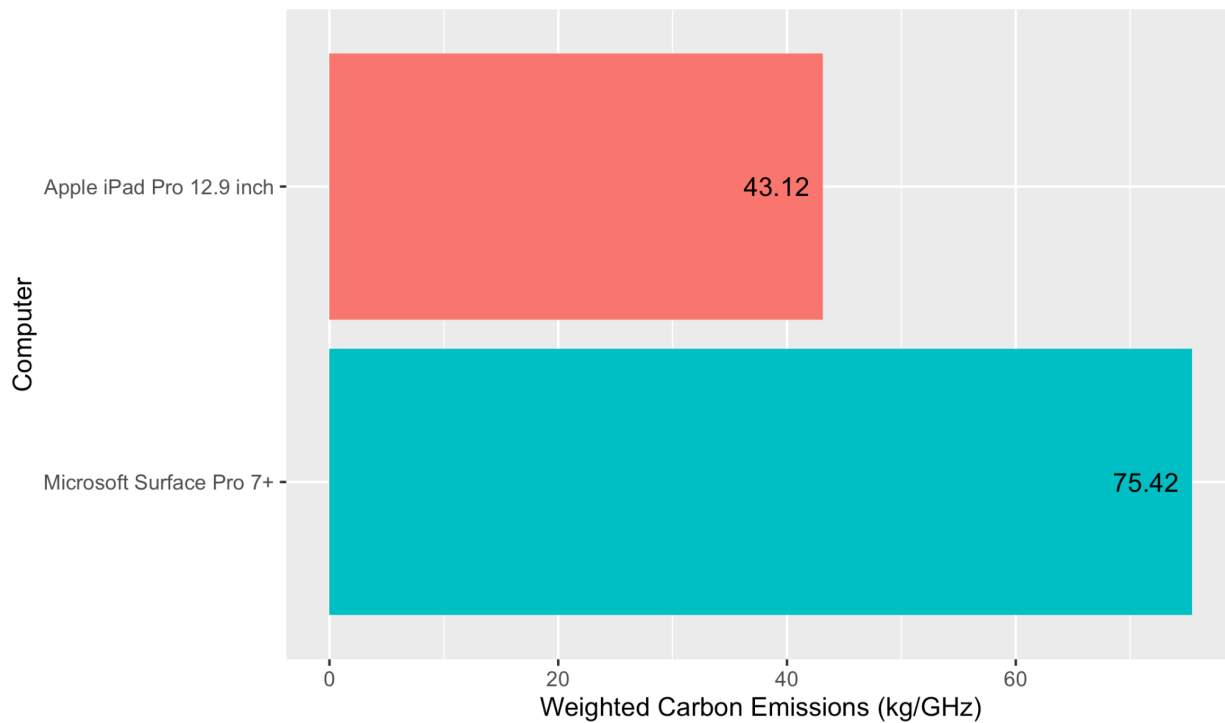
Carbon Emissions weighted by Processing Speed (kg/gHz) for Laptops



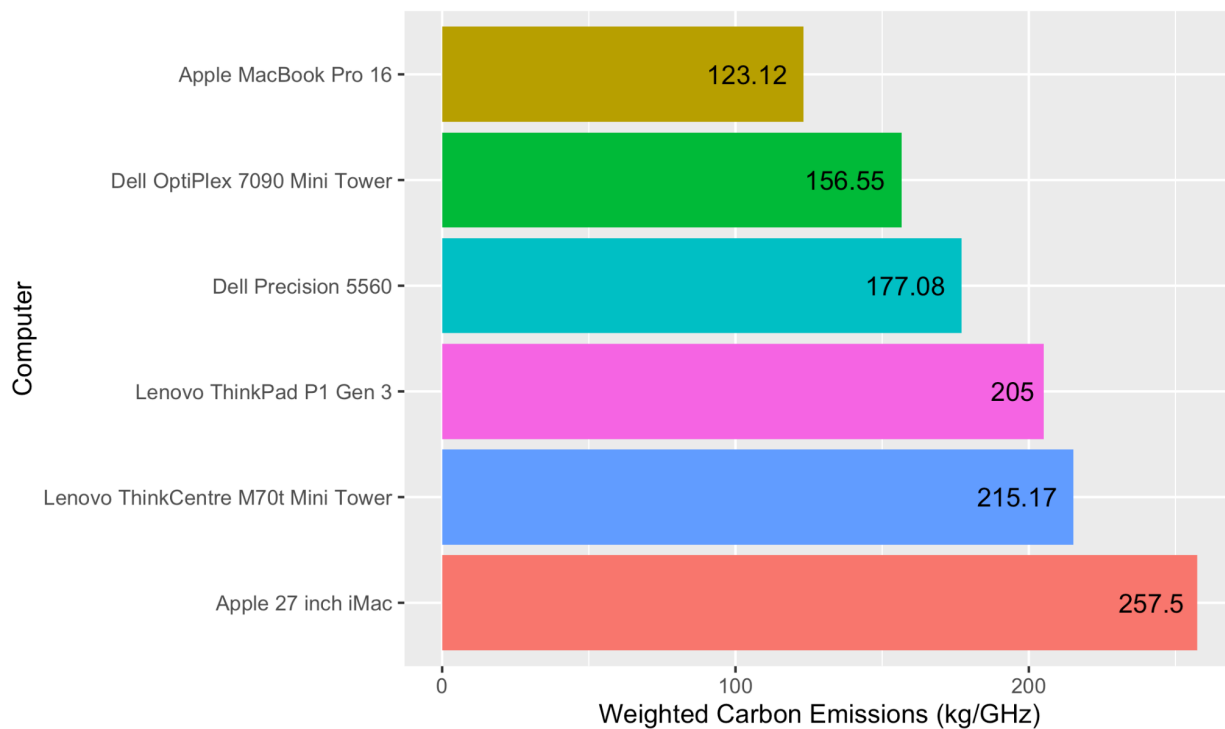
Carbon Emissions weighted by Processing Speed (kg/GHz) for Desktop Computers



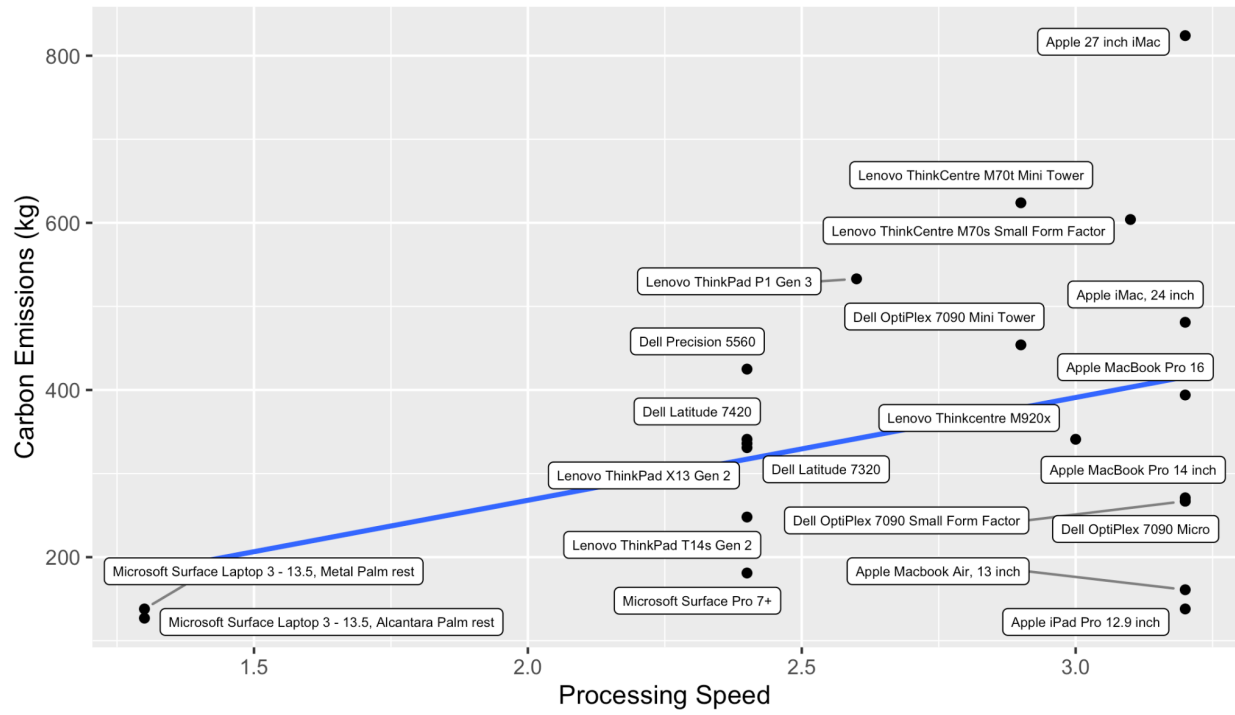
Carbon Emissions weighted by Processing Speed (kg/GHz) for Tablets



Carbon Emissions weighted by Processing Speed (kg/GHz) for Processor Intensive Computers



Carbon Emissions vs. Processing Speed for all Computers



Life Cycle Analysis (LCA) Methodologies:

Apple

The following excerpt is from Apple's 2022 [Environmental Progress Report](#), page 85.

Apple uses a five steps when conducting a product LCA:

1. To model the manufacturing phase, we use part-by-part measurements of the entire product along with data on part production. The measurements help us accurately determine the size and weight of the components and materials in the product, while data on manufacturing processes and yield loss during production allows us to account for the impact of manufacturing. The LCA includes accessories and packaging, as well as decreased emissions through Apple's Supplier Clean Energy Program. When calculating Apple's comprehensive carbon footprint, we also include units that are repaired and replaced through AppleCare
2. To model customer use, we measure the power consumed by a product while it is running in a simulated scenario. Daily usage patterns are specific to each product and are a mixture of actual and modeled customer use data. For the purposes of our assessment, years of use, which are based on first owners, are modeled to be four years for macOS and tvOS devices and three years for iOS, iPadOS, and watchOS devices. Most Apple products last longer and are often passed along, resold, or returned to Apple by the first owner for others to use. More information on our product energy use is provided in our Product Environmental Reports.
3. To model transportation, we use data collected on shipments of single products and multipack units by land, sea, and air. We account for transporting materials between manufacturing sites; transporting products from manufacturing sites to regional distribution hubs; transporting products from regional distribution hubs to individual customers; and transporting products from final customers to recycling facilities.
4. To model end of life, we use material composition data on our products and estimate the ratio of products that are sent to recycling or disposal. For products sent to recycling, we capture the initial processing by the recycler to prepare the product for recovery of electronic, metal, plastic, and glass material streams. Subsequent downstream recycling processes are not included, as these are considered stages of production and not end-of-life processing. For products sent to disposal, we capture the emissions associated with landfilling or incineration of each type of material.
5. After we collect data about manufacturing, use, transportation, and end of life, we combine it with detailed greenhouse gas emission data. This emission data is based on a combination of Apple-specific and industry-average datasets for material production, manufacturing processes, electricity generation, and transportation. Renewable energy used in the supply chain, initiated by suppliers independently or through the Apple Supplier Clean Energy Program, is also accounted for within the LCA model. Combining

product-specific information with emission data in our LCA allows us to compile detailed results for greenhouse gas emissions as they relate to each product. The data and modeling approaches are checked for quality and accuracy by the Fraunhofer Institute in Germany.

There is inherent uncertainty in modeling carbon emissions due primarily to data limitations. For the top component contributors to Apple's carbon emissions, Apple addresses this uncertainty by developing detailed process-based environmental models with Apple-specific parameters. For the remaining elements of Apple's carbon footprint, we rely on industry average data and assumptions.

Dell

Dell uses the Product Attribute to Impact Algorithm (PAIA) model developed by MIT's Materials System Laboratory. More information about PAIA can be found here:

<https://msl.mit.edu/projects/paia/main.html>. There is a tool that delivers the estimations: <https://paia-tool.com/#/>.

Lenovo

Lenovo also uses the Product Attribute to Impact Algorithm (PAIA) model developed by MIT's Materials System Laboratory, which is detailed above. Furthermore, Lenovo reports the 95th percentile of emissions to account for uncertainty, rather than just the median.

Microsoft

The following excerpt is from

<https://www.microsoft.com/en-us/legal/compliance/environmental-compliance>.

How does Microsoft calculate its lifecycle assessments (LCA)?

The results of an LCA depend on the calculation method, scope, and assumptions used. Thus, assessments of different producers are not comparable even though general LCA standards are available. We use the ISO 14040 and ISO 14044 standards, complemented by ETSI TS 103 199 and ITU-T L.1410, as a framework for our calculations. Our LCA calculations include the entire lifecycle, from raw material acquisition through end-of-life disposal.

Over time, we evaluate different LCA methodologies, tools, and databases. As the LCAs, devices, and technologies are continuously evolving, our LCA results represent our best understanding of LCA impacts at the time of publication and are revised when needed.

What do our lifecycle assessments (LCA) cover?

Our LCAs cover the product, its retail packaging, and its power supply unit, unless otherwise specified in the Ecoprofile. LCAs are cradle-to-grave, meaning that we include the entire lifecycle of the product: manufacturing, distribution to customer, product use, and end-of-life treatment. The manufacturing stage includes extraction of raw materials, upstream materials preparation, electronic component manufacturing, subassembly manufacturing and assembly, and final assembly. For our LCA calculations for Surface products, we assume that the products are in use for three years. In the calculations for Xbox consoles, we assume five years of use. The use phase accounts for both active and idle time usage (for example, when the device is energized but not in active use). For the transportation phase, both inbound and outbound logistics are included. The recycling phase calculations cover activities up to and including shredding of materials. The environmental impacts of other accessories are not included but may be reported separately. Software and hardware design impacts are captured in our corporate carbon footprint and excluded from the individual product LCA calculations.