

User Guide for EPEAT Benefits Calculator

Introduction

This environmental benefits calculator, developed by the Global Electronics Council (GEC), allows purchasers to assess the environmental benefits associated with purchasing IT products that meet the sustainability criteria of GEC's EPEAT ecolabel — the leading global ecolabel for the IT sector.

By purchasing and using EPEAT-labeled IT products, organizations lessen their impact on the environment, including reducing greenhouse gas emissions, energy use, and generation of toxic substances and solid waste. GEC's calculator enables purchasers to quantify these and other environmental benefits associated with their purchase of sustainable IT products.

This benefits calculator covers three product categories - mobile phones, servers, and computers and displays (for criteria updated in 2018). For purchasing EPEAT imaging equipment and televisions, the US Environmental Protection Agency (EPA) maintains similar benefits tools.¹

For more information on the EPEAT program or the use of this calculator contact us at EPEAT@GlobalElectronicsCouncil.org.

How the calculator estimates the lifecycle benefits of purchasing EPEAT products

A lifecycle approach is used to estimate the benefits of purchasing and using EPEAT products compared to non-EPEAT products. The analysis captures environmental impacts associated with raw material extraction, component, and product manufacturing and energy consumed during product use. The lifecycle benefits estimate the reduction in impacts resulting from product design and manufacturing changes reflected in EPEAT-registered products.

The end-of-life analysis (optional data entry) estimates the potential benefits of reusing and recycling the EPEAT products when they are taken out of service compared to sending the products for disposal in landfill. The calculator also estimates the additional environmental benefits that can result from keeping the products in use longer before replacement, which avoids impacts associated with producing new products and components.

The calculator uses LCA software² to model the environmental impacts from producing, using, reusing and recycling EPEAT registered products and baseline (non-EPEAT) products. Industry studies combined with expert review augmented the software data, as needed to address specific EPEAT criteria.

Benefit savings represent the difference in lifecycle impacts for EPEAT and non-EPEAT products, based on performance criteria in the relevant product standards.³ All EPEAT products are assumed to meet the

¹ US EPA Electronics Environmental Benefits Calculators (EEBC) can be accessed at <https://www.epa.gov/greenerproducts/electronic-product-environmental-assessment-tool-peat>.

² PRe Consultants SimaPro LCA Software version 8.5.0.0. Models for EPEAT and non-EPEAT products, accessories, packaging, and recycling were constructed in SimaPro using ecoinvent 3.4 unit process data sets (ecoinvent 3.4 database compiled November 2017)

³ American National Standard (ANSI)/Underwriters Laboratories (UL) ANSI/UL 110 Standard for Sustainability of Mobile Phones, Second Edition, March 24, 2017.

required criteria in the standard. The optional criteria differentiate between the three EPEAT levels—bronze, silver, and gold. Note that only those criteria that can be quantitatively measured at this time are included in the benefits calculations; for example, environmental benefits of providing a user or recycler with documentation is not quantifiable. Appendix A summarizes the major data sources and assumptions for EPEAT and non-EPEAT products.

Using the calculator

The EPEAT benefits calculator⁴ is separated into three product categories, or modules – mobile phones, servers, and computer and displays. The product specific section of the calculator can be accessed using the product icons shown on the opening page. To run the calculator for one product category, enter data into data entry fields, then hit the “Get Results” button. To run the calculator for multiple product types, enter data into each product category using the product icons at the top of the page, and hit the “Get Results” button after all data entry is complete. The calculator will store all data entered until the “Reset” button is used, or the user leaves the calculator webpage, which allows the user to modify data entry, if needed.

Required input

Before using the calculator, you will need to know the number of EPEAT products purchased and the registered EPEAT levels (bronze, silver, gold). You will also be required to enter the region where the products are being used by using the drop-down menu. The regional choices are North America, South and Central America, Europe, China, and Asia Oceania based on International Energy Agency (IEA) regional statistics. If uncertain, see Appendix B for country listing by region.

Optional input

After entering the required data, you have the option of customizing your results by clicking on the Optional Data Entry icon. The sections below explain how environmental benefits are calculated for optional data inputs.

Energy

The calculator estimates the environmental impacts from electricity production during the use phase based on the IEA regional energy fuel mix for the IEA region selected in the required data section. However, you can customize the cost of your electricity by entering the cost per kWh at your location in the first optional entry box. After entering the value for the cost/kWh, use the drop-down menu to select the currency for the electricity cost you entered. For example, if a Canadian user enters the cost/kWh value corresponding to currency units of Canadian dollars, select “Dollars” from the drop-down currency options. The cost savings shown in the results table will then show the energy savings in Canadian dollars (number of kWh saved multiplied by the cost/kWh in Canadian dollars). The calculator relies on your input

NSF International Standard (NSF)/American National Standard (ANSI) NSF/ANSI 426 Environmental Leadership and Corporate Social Responsibility Assessment of Servers, August 7, 2017.

The Institute of Electrical and Electronics Engineers (IEEE) Computer Society 1680.1™-2018 Standard for Environmental and Social Responsibility Assessment of Computers and Displays, February 15, 2018.

⁴ The EPEAT calculator is accessed through the GEC website at <http://greenelectronicscouncil.org/>.

and does not convert currency values. **If you choose to skip the optional energy cost during user input, the energy cost will be shown based on the US cost/kWh in US dollars.**

Extended Product Use, Donating the Product for Reuse, and Recycling

- *How long do you plan to use the products on average (in months)?*

The calculator shows the environmental and economic savings resulting from using the product longer than the calculator default, which varies by product (mobile phones 22.7 months; servers 48 months; desktop, notebook, tablet and integrated computers 48 months; monitor 72 months). If you enter a value less than the default, the calculator assumes the default period of use.

Extending the product life will impact two phases: 1) savings during the product use phase, due to the improved energy efficiency of the product (e.g., more energy efficient mobile phone charging), and 2) savings from avoided production of a fraction of the product and packaging as determined by length of the extended life. When viewing the main aggregated table, the use phase energy benefits of extending product life are reflected in the Purchasing EPEAT Products row, and the avoided production benefits of extended use are included in the Optional Reuse and Recycling row.

In the more detailed lifecycle phase results table, the product use phase savings for extended useful life are shown in the Product Energy Use row, and the savings for avoided production are shown in the Optional Reuse and Recycling row. Note that the Optional Reuse and Recycling phase row of the results table will also include impacts for any product reuse or recycling entered by the user. Therefore, if you wish to view only the avoided production benefits for extended use by the first user, enter the number of months for the extended life but do not enter any data into the reuse or recycling optional data entry fields.

- *How many of the products purchased do you plan to manage through reuse or recycling?*

Mobile phones that go to a secondary user are assumed to undergo a minimal refurbishing process in which the battery is replaced, and the original battery is recycled. No other part replacements or repairs are modeled. The calculator estimates the savings from avoiding the production of a new baseline phone, with no projections about the fate of the mobile phone after the secondary use. Refurbished phones are issued with a new adapter, charging cord, and packaging, so production of these items is not avoided. The calculator estimates the impacts of recycling processes and assigns credits for avoiding virgin production of the materials recovered from the recycled mobile phones and batteries. Recycling also avoids landfill disposal of the phone and battery.

Servers that are returned to the original equipment manufacturer or recycler are assumed to undergo evaluation to determine which products can be reused, harvested for parts, and recycled. The calculator estimates the reuse savings from avoiding the production of a new baseline server, with no projections about the fate of the server after the secondary use. Servers harvested for

parts are disassembled/dismantled to extract memory devices, cables, batteries and mainboards from the chassis. These components are either reused in new or remanufactured servers or recycled. The fraction of servers not reused or harvested for parts are recycled.

Computer products reused by a secondary user are assumed to avoid the impacts from producing a new baseline product, external power supply (for notebook and tablet), and packaging. Reused desktop and integrated computers are assumed to be donated without a keyboard or mouse, so production of these accessories is not avoided. Reused notebooks and tablets are assumed to have the battery replaced, so production of a new battery is not avoided, and the reuse credits are adjusted for the impacts of recycling the original battery. The calculator estimates the impacts of recycling processes and assigns credits for avoiding virgin production of the materials recovered from the recycled products, as well as some energy credits for combustion of plastics. Recycling also avoids landfill disposal of the product and battery.

- *Number of products disposed of at end of life?*
Calculator automatically calculates the number of products going to landfill by subtracting the number of products reused and recycled from the number purchased. **Note that if the user leaves the reuse and recycling fields blank, no disposal of any type (including landfill) will be modeled.** If the user enters a zero in either or both reuse and recycling fields, purchased products not recycled or reused will be modeled as landfilled.

Additional Customization

- *[For mobile phones] Average weight per unit*
The calculator allows you to customize your mobile phone purchase by entering the weight in grams of the mobile phone with battery (excluding adapters, charging cord, or packaging). Most manufacturer specifications show the weight of the mobile phone with battery. The calculator scales the weights of the display, housing, and battery as the mobile phone weight increases. The other components such as the circuit board, capacitors, and camera are assumed to remain the same as in the default mobile phone.
- *[For servers and computer products] Are you purchasing some or all of the units entered above in bulk packaging?*
Reducing excess packaging with bulk packaging containing multiple units lowers environmental impacts from production of packaging material and from increased transportation efficiency. An example of bulk packaging is four servers in a single box. The optional bulk packaging question customizes EPEAT purchases for servers and/or computers and displays by applying the specified percentage of units in bulk packaging to the number of products purchased at each EPEAT level. If less than one hundred percent of the purchased units are purchased in bulk packaging, the remaining products are assumed to be packaged in single-product packaging.

- *[For rack servers] Do the purchased rack servers have >2 CPUs per server?*
Energy consumption during product use is a major contributor to the lifecycle environmental impacts of servers. The rack server default assumption of 2 CPUs per server can be customized if rack units are purchased with more than 2 CPUs per unit. Selecting this option (“yes”) replaces the default energy consumption for 2 installed processors with energy consumption estimates for rack servers with greater than 2 installed processors, provided by EPA’s ENERGY STAR program. ENERGY STAR values are calculated from the composite performance (numerator) and composite power (denominator) of overall SERT scores for each products’ typical configuration.

Understanding the EPEAT benefits calculator results

The calculator displays the benefits of purchasing EPEAT products on a single page with expandable sections. The aggregate benefit results are shown in the main table in two categories:

- Purchasing EPEAT Products
- Optional Reuse and Recycling

See below for an explanation of the results, as well as options for viewing results by product and lifecycle phase.

To view the data that you entered, click on the first expandable section “Data entered” which summarizes data entered on the first page.

The results table includes 12 environmental and cost benefits. The calculator defaults with all benefit categories selected and shown in the table. However, you have the option of viewing a selection of individual categories by checking or unchecking the individual benefit category boxes.

To return to the data entry page, use the product icon buttons at the top of the page.

Table 1 defines the key terms as used in the results tables.

Table 1. Definitions of Key Terms Used	
Purchasing	<i>Purchasing EPEAT products</i> includes raw material extraction through product manufacturing, transport, and product use. Purchasing does not include end of life management of the product or any associated components.
Manufacturing	<i>Manufacturing</i> includes all steps from raw material extraction through product manufacturing and transport for production of the product and packaging. For mobile phone calculator , this includes the phone, battery, adapter, charging cord, and packaging. For server calculator , manufacturing includes the server and its packaging. Rack servers includes cables/power cords. The blade server modeled is the blade unit only, since the server standard covers the blade unit only and excludes the shared enclosure.

Table 1. Definitions of Key Terms Used	
	For computer products and display calculator , manufacturing includes the products, cables/power cords, and packaging. Notebook and tablet computers manufacturing includes an external power supply and long-life battery.
Use	<p><i>Use of EPEAT products</i> by the initial user is included in the aggregate Purchasing results. The environmental benefits attributed to energy-efficiency of the product during use are broken out in the detailed results by lifecycle phase.</p> <p>Use of EPEAT products is credited for the reductions in electricity-related impacts due to energy efficiency of EPEAT products during the period used by the initial user. Reduced impacts from electricity consumption are based on average regional grid fuel mixes from International Energy Agency (IEA) statistics for the geographical region chosen (North America, South and Central America, Europe, China, and Asia Oceania). See Appendix B for country listing by region.</p> <p>Energy savings during use are calculated based on kWh saved and the cost per kWh entered by the user in the currency selected by the user. If no currency is specified, the calculator uses US cost per kWh in US dollar.</p>
End of life management (optional)	<p>The optional section of the calculator has several options that affect the end of life results for purchased phones:</p> <ul style="list-style-type: none"> • Reuse by a secondary user • Recycling • Landfill <p>Users can leave this section blank, in which case no end of life modeling of the EPEAT products is included. If the user enters any number of purchased phones for any end of life option(s), the purchased products with no fate specified are modeled as going to landfill.</p> <p>Impacts from end of life management options (reuse, recycling or landfilling of the EPEAT products) are not included in the impacts estimated for purchasing.</p>

Benefits

Table 2 lists the environmental and economic benefits with a short description for each. These explanations are also available by clicking the information icon for each metric on the results page.

Total energy savings is displayed with two units of measurement to meet the most common reporting requirements (megajoules and kilowatt hour equivalents).

Savings are shown to two decimal places. For some categories such as toxic materials, the results may be <0.01. However, when <0.01 appears in the results for non-hazardous solid waste, water consumption, and non-hazardous solid waste disposal costs, this may indicate a situation where increased use of recycled content or recyclable fiber in EPEAT products or packaging results in trade offs. For example,

recycled plastic requires more water consumption during the recycling process compared to production of virgin resins but use of recycled plastic results in benefits in other categories such as reduced energy consumption and greenhouse gas emissions.

Table 2. Benefits of Purchasing EPEAT Products	
Benefit	Description
Total energy savings (in megajoules and kilowatt hour equivalents)	Total energy used during the lifecycle of the equipment, from point of extraction; results include both renewable and non-renewable energy sources.
Greenhouse gas emissions expressed as global warming potential (kg CO ₂ eq)	Represents the heat trapping capacity of the greenhouse gases released during the lifecycle. Important emissions: CO ₂ fossil, CH ₄ , N ₂ O, chlorinated and fluorinated hydrocarbons.
Non-hazardous solid waste	Total weight of fuel-related, process-related and postconsumer wastes disposed from the product lifecycle.
Water consumption	Freshwater withdrawals which are evaporated, incorporated into products and waste, transferred to different watersheds, or disposed into the sea after usage.
Acidification potential	Addition of acids (e.g., nitric acid and sulfuric acid) into the environment, or emissions of other substances (e.g., ammonia) that increase the acidity of the environment due to various chemical reactions and/or biological activity. Acidification can cause damage to forests, ecosystems, and buildings. Important emissions include SO ₂ , NO _x , NH ₃ , HCl, HF, H ₂ S, and more.
Smog formation potential	Characterizes potential of emissions to form reactive substances (e.g. tropospheric ozone) that can cause harm to human health and vegetation. Important emissions include NO _x , BTEX, NMVOC, CH ₄ , etc.
Eutrophication potential	Assesses impacts from excessive load of macro-nutrients (nitrates, phosphates) to the environment, which can lead to results such as algal blooms and fish kills. Important emissions include NH ₃ , NO _x , COD and BOD, N and P compounds.
Toxic material used in the product	Total mass of toxic and restricted substances in devices.
Material conservation	Reduction in mass of virgin material consumption due to increased recycled content of EPEAT devices and packaging.
Non-hazardous solid waste disposal cost	Cost of non-hazardous waste disposal.

Table 2. Benefits of Purchasing EPEAT Products	
Benefit	Description
Cost savings for energy use	Costs associated with the electricity used during the useful life of the equipment.

Results report levels

The calculator displays the results in several ways.

Reduction in Environmental Impacts and Costs Resulting from Purchasing EPEAT

Aggregate results are presented in the main table for Purchasing EPEAT Products and the Optional Reuse and Recycling data entry, if applicable. Purchasing EPEAT products includes the reduction in impacts and costs associated with raw material extraction through product manufacturing and transport plus the energy savings associated with electricity consumption during use by the initial user. This high level display sums all products and all EPEAT levels into a single value for each metric.

Show me more details Reduction in Environmental Impacts and Costs

A series of expandable tables allows you to see more detailed results, including: By Product Category, By Product Type, and By Lifecycle Phase. Clicking on the symbol displays the benefit reductions in more detail.

- *By Product Category*: This table displays the benefits of purchasing EPEAT mobile phones, servers, and computer and displays which includes the benefits for raw material extraction through EPEAT product manufacturing and transport plus the energy savings associated with electricity consumption during use by the initial user. The summation of these three rows is equal to the high-level results shown in the aggregate results table discussed above.
- *By Product Type*: Since the calculator only estimates saving for one type of mobile phone, these results are the same as results for *By Product Category*. For servers and computer products, this table breaks down the results by the product types included on the data input page, including: two types of servers (rack and blade) and five computer product types (desktop computer, computer display, notebook computer, tablet computer, and integrated desktop computer).
- *By Lifecycle Phase* –The benefits of raw material extraction through manufacturing and transport, energy savings associated with electricity consumption during use by the initial user, and end of life management of EPEAT products are shown in this table.

The summation of the first two rows (Raw Material Extraction Through Manufacturing and Transport and Product Energy Use) is equal to the product results shown in the *By Product Category* table.

The Optional Reuse and Recycling rows shows the reduction in environmental impacts resulting from reuse and recycling of EPEAT products at end of life. If the initial user has extended the useful life beyond the calculator's default value, the benefits of avoiding production of a new product and packaging are included. Savings are based on not producing a fraction of new products, as

determined by length of the extended life. If you choose not to enter any reuse, recycling or extended life optional data, no results will show in this row.

The Total All Lifecycle Phases row is a summation of the three rows in these tables.

Excel Download

Below the benefits results table, there is an Excel Download button. Clicking on this will generate an Excel table with your data input and results that can be used for reporting purposes.

Equivalencies table

The last expandable table shows the aggregate benefits results as equivalencies. The calculator translates your results into familiar tangible terms, such as the number of households that could be powered by the energy savings benefit from purchasing EPEAT products or the equivalent number of US households' annual trash represented by the non-hazardous solid waste savings (reduction) benefit. The equivalencies are calculated using the Total row under *Reduction in Environmental Impacts and Costs Resulting from Purchasing EPEAT* (third line of results). If you want to calculate equivalencies for other rows of results, click on Data and Assumptions for Equivalencies, which can be applied to the respective results.

Calculator Development

GEC, working with Eastern Research Group (ERG), developed this new benefits calculator. ERG previously developed and maintained the US EPA Electronics Environmental Benefits Calculator (EEBC), which will help maintain consistency in approach and output between the EPA calculator and the new GEC EPEAT benefits calculator. GEC engaged an external technical review panel comprised of representatives from industry, government, academia, technical consultancies, and organizations purchasing IT products, to review the data, assumptions and analysis underlying the calculator results.

GEC extends its appreciation to the many individuals that contributed to the technical review of the extensive data and analysis supporting the benefits calculations and that provided feedback on the web-based calculator. Technical reviewers included: Callie Babbitt, Rochester Institute of Technology; Cate Berard, U.S. Department of Energy; Christina Bocher, DEKRA; John Clinger, ICF (supporting U.S. ENERGY STAR); Holly Elwood, U.S. Environmental Protection Agency; Stacey Foreman, City of Portland, Oregon; Derek Hellar; Hewlett Packard Enterprise; Bill Hoffman, UL Environment; Stephanie Le Clerc, McGill University; Karsten Schischke, Anton Berwald, Marina Proske and Lutz Stobbe, Fraunhofer IZM ; and Fallight Xu, TÜV Rheinland.

Appendix A. Data Sources and Assumptions for EPEAT and Non-EPEAT Products

<p>Mobile phones</p>	<p><i>Mobile phone composition</i> is based on the bill of materials for a smart phone shown in Güvendik, M. 2014. From Smartphone to Futurephone: Assessing the Environmental Impacts of Different Circular Economy Scenarios of a Smartphone Using LCA. August 31.</p> <p>Some adjustments were made to the battery composition and metal use in the mobile phone based on expert review.</p> <p><i>Mobile phone weight</i> (128.97 grams) including battery is based on adjusted bill of materials. Weight does not include adapter, charging cord, or packaging.</p> <p><i>Mobile phone life</i> default is 22.7 months unless user enters data in the optional section for extended life. If entered product life is less than the default, the calculator will assume the default value.</p> <p><i>Extending product life</i> benefits are compared to default life of EPEAT mobile phone (22.7 months). Savings are based on not producing a fraction of new product, battery, adapter, charging cord, and packaging, as determined by length of the extended life. The avoided new phone fraction is calculated as (user-specified months of use - 22.7 months) / 22.7.</p> <p>If mobile phone is used longer than default battery life (56.4 months), a replacement battery is required, the fraction for new product battery is not credited, and overall savings are reduced by the impacts of recycling the old battery.</p> <p><i>Reuse through donation</i> to another user is modeled as follows: Each phone reused is credited with avoiding impacts for producing a new baseline phone. Refurbished phones are assumed to have the battery replaced before reissue, so production burdens of a new battery are included. The reuse credits are adjusted for the impacts of recycling the original battery. Refurbished phones are issued with a new adapter, charging cord, and packaging, so production of these items is not avoided. No assumptions are made about the fate of the mobile phone after the secondary use.</p> <p><i>Recycling benefits</i> are estimated relative to landfill disposal of EPEAT phone. The calculator estimates the benefits of recycling the purchased phone as follows: Recycling process impacts for mobile phones are based on Ecoinvent data for treatment of electronic waste and batteries, and subsequent separation and refining of metals recovered from electronic waste. Amounts of recovered metals are based on amounts of metals in the components of the phone and battery and published recovery rates for metals from recycling of phones and batteries. The end amounts of refined metals recovered from mobile phone and battery recycling are credited with displacing production of equivalent amounts of virgin refined metals.</p> <p><i>The impacts of landfilling</i> are limited to the weight of the phone (including battery) that would be disposed to a landfill. No impacts are modeled for potential long-term degradation or leaching of phone materials over time in the landfill. The model does not include impacts for recycling or disposal of adapters, charging cord, or phone packaging since user may keep adapters and charging cord as backups when they dispose of phone.</p> <p>Non-hazardous solid waste disposal costs are based on US 2013 average landfill tipping fee (\$50.59 per short ton). The US disposal cost is used to quantify landfill disposal regardless of the use region selected by the user.</p>
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Mobile phone EPEAT criteria assumptions	<p>[criterion 8.1.2] Post-consumer recycled plastic content in the mobile phone is calculated as a percentage of total plastic (by weight) in the mobile phone.</p> <p>Based on the EPEAT registry, the calculator assumes 5% recycled content for bronze level and 10% for both silver and gold levels.</p>
	<p>[criterion 8.1.3] Post-consumer recycled plastic content in the accessories (adapter and charging cord) is calculated as a percentage of total plastic (by weight) in the mobile phone.</p> <p>Based on the EPEAT registry, the calculator assumes 0% recycled content for bronze and silver levels and 5% for gold level.</p>
	<p>[criterion 9.2.2] DEHP, DBP, and BBP levels are assumed at zero for EPEAT levels since phthalates are in PVC, and manufacturers are eliminating PVC from devices and replacing PVC cord coatings with materials like thermoplastic elastomers.</p>
	<p>[criterion 9.2.3] Chlorine levels are based on maximum Cl level allowed by the product standard in charging cord coating. Bromine levels are assumed at zero in circuit board resin, based on industry expert review. Due to lack ofecoinvent data on flame retardant production, the manufacture of flame retardants (brominated and non-brominated) are not included in the calculator.</p>
	<p>[criteria 10.1.2 & 10.1.4] Energy efficiency based on Federal Energy Conservation Standards for Battery Chargers Final Rule and U.S. Department of Energy (DOE) Efficiency Regulations for External Power Supplies. Differentiation between EPEAT levels based on manufacturer declarations in EPEAT registry.</p>
	<p>[criterion 12.1.1] Use of recyclable fiber-based packaging materials for EPEAT silver and gold levels is based on manufacturer declarations in EPEAT registry (70% silver, and 86% gold). Bronze was assumed at 50% based on consultant judgement.</p>
	<p>[criterion 12.3.1] Use of post-consumer recycled plastic packaging for EPEAT silver and gold levels is based on manufacturer declarations in EPEAT registry (10% silver, and 12% gold). Bronze was modeled conservatively at 0% based on consultant judgement.</p>
	<p>[criterion 12.5.1] Recycled content of chipboard packaging and corrugated packaging materials are assumed to meet the minimum requirements of the product standard (80% and 35%, respectively) for EPEAT products.</p>
	<p>[criterion 12.6.2] Environmentally preferable paper/paperboard for printed content assumed at the minimum level recycled content required by the product standard (60%) for the silver and gold EPEAT levels. Bronze was modeled conservatively at 0% based on consultant judgement.</p>
	<p>[criterion 12.9.1] Improved packaging efficiency was assumed for silver and gold levels at 38% and 60% reductions in packaging volume, respectively, based on reporting in the EPEAT registry. Corresponding reductions in packaging weights were estimated based on a report on packaging reductions for a large mobile phone company.</p>

	<p>[criterion 15.4.1] Reduction of fluorinated gas emissions in flat panel display manufacturing is based on EPEAT registry responses for silver and gold level products applied to fluorinated gas emissions data for LCD screen manufacturing from an industry study.</p>
<p>Non-EPEAT (baseline) mobile phones</p>	<p>Non-EPEAT baseline mobile phone was assumed to reflect average technology. In cases where standards specified recycled content criteria for EPEAT products, the non-EPEAT product was modeled with 0% recycled content. The non-EPEAT baseline mobile phone was not assumed to meet the sustainability criteria listed for EPEAT mobile phones.</p>
	<p>Chlorine and bromine levels for non-EPEAT is based on Cl in weight of charging cord coating (assuming PVC) and average Br level in circuit board resin is based on use of TBBPA flame retardant.</p>
	<p>GHG emissions for paper/paperboard point-of-sale packaging in non-EPEAT mobile phone were estimated to be 5% higher than EPEAT mobile phones packaging using sustainably sourced fiber. This assumption is based on an industry study.</p>
<p>Servers</p>	<p><i>Server composition</i> is based on the bill of materials for a 2 RU (rack unit) 2 CPU server and a 2 CPU blade server shown in Bio by Deloitte (2015), Preparatory study for implementing measures of the Ecodesign Directive 2009/125/EC DG ENTR Lot 9 - Enterprise servers and data equipment - Task 5: Environment & Economics.</p>
	<p><i>Energy consumption</i> data provided by U.S. ENERGY STAR program, based on SERT scores which incorporate energy efficiency for active state and idle state power management. EPEAT servers assumed to meet ENERGY STAR version 3.0 with 2 installed processors (rack and blade servers). Optional data input (available for rack servers only) uses energy consumption data for greater than 2 installed processors per rack server.</p>
	<p><i>Server life</i> default is 48 months unless user enters data in the optional section for extended life. If entered product life is less than the default, the calculator will assume the default value.</p> <p><i>Extending product life</i> benefits are compared to default life of EPEAT servers (48 months). Savings are based on not producing a fraction of new product, cables, and packaging, as determined by length of the extended life. The avoided new server fraction is calculated as (user-specified months of use - 48 months) / 48.</p> <p>Using equipment longer may avoid production of newer more energy efficient products. Calculator measures extended life benefits on servers modeled and does not predict future technology changes.</p>
	<p><i>Reuse and recycling benefits</i> of servers collected by original equipment manufacturer or recycler are modeled as follows:</p> <p>Reuse and recycling benefits are those realized through processing and do not cover collection burdens.</p> <p>Net impacts per server collected for reuse and recycling include 50% of servers reused and 50% recycled. Of servers reused, half (25%) assumed to be reused as whole servers with parts scavenged from other half (25%) of servers reused; remainder of scavenged servers are assumed to be recycled. Each server reused is credited with avoiding impacts for producing a new baseline server.</p>

	<p><i>Recycling benefits</i> are estimated relative to landfill disposal of EPEAT servers. The calculator estimates the benefits of recycling the purchased server as follows: Recycling process impacts are based on Ecoinvent data for treatment of electronic waste and batteries, and subsequent separation and refining of metals recovered from electronic waste. Recycling includes recovery of metals, waste-to-energy of plastics, recycling of electronic components, and recycling of batteries.</p> <p>Amounts of recovered metals are based on amounts of metals in the components of the servers and published recovery rates for metals from recycling of computer products. The end amounts of refined metals recovered from server recycling are credited with displacing production of equivalent amounts of virgin refined metals.</p> <p><i>The impacts of landfilling</i> are limited to the weight of the servers that would be disposed to a landfill. No impacts are modeled for potential long-term degradation or leaching of server materials over time in the landfill. The model does not include impacts for recycling or disposal of server packaging.</p> <p>Non-hazardous solid waste disposal costs are based on US 2013 average landfill tipping fee (\$50.59 per short ton). The US disposal cost is used to quantify landfill disposal regardless of the use region selected by the user.</p>
<p>Server EPEAT criteria assumptions</p>	<p>[criterion 5.1.1] EPEAT servers assumed to meet ENERGY STAR version 3.0 Final Specification – September 17, 2018.</p> <p>[criterion 5.3.1] Power supply energy efficiency based on 80 Plus Program Titanium level performance (96%) applied to Gold level EPEAT servers</p> <p>[criterion 5.4.2] Server inactive power state #1 is assumed at 0.5% reduction in power consumption for silver and gold EPEAT servers. 0.5% is a placeholder assumption until data become available.</p> <p>[criterion 6.1.3] Chlorine levels in baseline products are based on Cl content in PVC parts; assumed at zero for EPEAT per tech review comments on corresponding criterion for mobile phones. Bromine levels are assumed at zero in circuit board resin, based on industry expert review. Due to lack of ecoinvent data on flame retardant production, the manufacture of flame retardants (brominated and non-brominated) are not included in the calculator.</p> <p>[criterion 6.3.1] Fluorinated emission (F-GHG) reduction for CPU manufacturing based on World Semiconductor Council. Best Practice Guidance for Semiconductor PFC Emission Reduction. May 18, 2017; adjusted based on industry expert review. Baseline and bronze level servers assumed at 30% reduction over reported 2010 reference point; silver and gold EPEAT levels assumed at 90% reduction over 2010 reference point.</p> <p>[criterion 7.1.4] Credit given for rare earth metal recovery from HDD magnets, based on data provided by industry experts. Credits given to silver and gold EPEAT products reduce the net amount of virgin Nd and Dy needed.</p> <p>[criteria 7.1.1 & 7.1.3] Post-consumer recycled plastic content in plastic parts in the server. The calculator assumes bronze EPEAT server recycled content of 16% for rack and 8% for blade servers, based on the EPEAT registry. Criterion 7.1.3 minimum recycled content levels assumed for silver (16% for rack and 10% for blade) and gold (25% for both rack and blade).</p>

	<p>[criteria 8.3.1 & 8.3.2] Recycled fiber in corrugated packaging is assumed at 25% for bronze level and 50% for silver and gold levels based on sustainability criteria. Baseline level is assumed at 10% based on EPA's WARM Version 14 documentation.</p>
	<p>[criterion 8.4.2] Bulk packaging is optional user data entry. Savings, based on industry data, will be applied to all EPEAT levels if user selects bulk packaging. Cartons 50% reduction; HDPE/ unspecified plastics 75% reduction; GPPS/ Styrofoam 80% reduction. Transportation volume 50% reduction.</p>
<p>Non-EPEAT (baseline) servers</p>	<p>Non-EPEAT baseline servers were assumed to reflect average technology, and not to meet the sustainability criteria modeled for EPEAT-registered products as outlined above. For recycled plastic content criteria, for example, the non-EPEAT product was modeled with 0% recycled content.</p> <p>Chlorine and bromine levels for non-EPEAT is based on Cl in weight of PVC components and average Br level in circuit board resin is based on use of TBBPA flame retardant.</p>

<p>Computer products and displays</p>	<p><i>Composition: Desktop computer</i> is based on the Ecoinvent bill of material (BOM) for "Computer, desktop, without screen {GLO} production"</p> <p><i>Monitor display</i> is based on the Ecoinvent BOM for "Display, liquid crystal, 17 inches {GLO} production," adjusted with HP Product Material Content Information, June 2018. Accessed at http://h20195.www2.hp.com/V2/getpdf.aspx/c05117791.pdf</p> <p><i>Notebook and tablet computers</i> are based on BOMs shown in Talens Peiró, L., Ardente, F., Mathieux, F., 2016. Analysis of material-efficiency aspects of Energy-related Product for the development of EU Ecolabel criteria — Analysis of product groups: personal computers and electronic displays. (doi:10.2788/642541)</p> <p><i>Integrated computer</i> is based on the BOM shown in Maya-Drysdale, Larisa, et al. Preparatory study on the Review of Regulation 617/2013 (Lot 3) Computers and Computer Servers Task 4 report Technologies Final version for consultation. February 2, 2017. Prepared for: European Commission DG ENER C.3 with additional composition detail on the Apple iMac integrated desktop from http://images.apple.com/environment/pdf/products/desktops/27inch_iMacR5K_PER_Oct2015.pdf.</p> <p><i>Desktop, notebook, tablet, and integrated computer</i> life defaults are 48 months and the <i>monitor</i> life default is 72 months, unless user enters data in the optional section for extended life. If entered product life for any product is less than the default, the calculator will assume the default value.</p> <p><i>Extending product life</i> benefits are compared to default life of EPEAT products (48 or 72 months). Savings are based on not producing a fraction of new product, accessories, and packaging, as determined by length of the extended life. For example, the avoided new desktop fraction is calculated as (user-specified months of use - 48 months) / 48.</p> <p>Using equipment longer may avoid production of newer more energy efficient products. Calculator measures extended life benefits on computer and display products as modeled and does not predict future technology changes.</p> <p>For extended use of notebooks and tablets past the life of the battery, impacts for battery replacement are included in the Use phase results.</p>
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	<p><i>Reuse and recycling benefits</i> of computer and display products reused by a second user or recycled by the original owner are modeled as follows: Reuse and recycling benefits are those realized through processing and do not cover collection burdens. Net impacts per product collected for reuse is credited with avoiding impacts for producing a new baseline product, external power supply, and packaging. Reused desktop and integrated computers are donated without a keyboard or mouse, so production of these accessories is not avoided. Reused laptops and notebooks have the battery replaced, so production of a new battery is not avoided, and the reuse credits are adjusted for the impacts of recycling the original battery.</p> <p><i>Recycling benefits</i> are estimated relative to landfill disposal of EPEAT computer and display products. The calculator estimates the benefits of recycling the purchased products as follows: Recycling process impacts are based on Ecoinvent data for treatment of electronic waste and batteries, and subsequent separation and refining of metals recovered from electronic waste. Recycling includes recovery of metals, recovery of some plastic in housings (ABS, polycarbonate, HDPE), waste-to-energy combustion of other plastics, recycling of electronic components, and recycling of batteries.</p> <p>Amounts of recovered plastics based on percentages shown in EPA’s WARM Version 14 documentation. The end amounts of recovered plastic are credited with displacing equivalent amounts of virgin plastics.</p> <p>Amounts of recovered metals are based on amounts of metals in the components of the products and published recovery rates⁵ for metals from recycling of computer products. The end amounts of refined metals recovered are credited with displacing production of equivalent amounts of virgin refined metals.</p>
<p>Computer products and displays</p> <p>EPEAT criteria assumptions</p>	<p><i>The impacts of landfilling</i> are limited to the weight of the computer and display products that would be disposed to a landfill. No impacts are modeled for potential long-term degradation or leaching of product materials over time in the landfill. The model does not include impacts for recycling or disposal of product packaging.</p> <p>Non-hazardous solid waste disposal costs are based on US 2013 average landfill tipping fee (\$50.59 per short ton). The US disposal cost is used to quantify landfill disposal regardless of the use region selected by the user.</p> <p>[criterion 4.5.1.1] EPEAT products assumed to meet ENERGY STAR Program Requirements Product Specification for Computers. Version 7.0 and Product Specification for Displays. Version 7.1. Notebook, tablet, and integrated computers based on ENERGY STAR Program Requirements Product Specification for Computers. Version 7.0. Rev. October 2018. Desktop and monitor energy consumption based on ENERGY STAR unpublished data (December 2018).</p>
	<p>[criterion 4.5.1.3] EPEAT minimum standard for energy efficiency for internal power supplies (as stated in ENERGY STAR 7.0 Table 2 at 50% load) assumed for bronze (90%); silver assumed at 1 point</p>

⁵ Tecchio P., Ardente F., Marwede M., Clemm C., Dimitrova G. Mathieux F. Analysis of material efficiency aspects of personal computers product group. January 2018. (<https://computerregulationreview.eu/documents>)

	<p>higher (91%); gold assumed at 2 points higher (92%). ENERGY STAR use phase power consumption data are used for bronze devices and assumed to include internal power supply efficiency. Energy use for silver and gold devices are adjusted for the higher internal power supply efficiency compared to bronze.</p>
	<p>[criterion 4.5.1.4] Energy efficiencies for external power supplies (relevant for notebooks and tablets) are based on the International External Power Supply Efficiency Level VI “International Efficiency Marking Protocol for External Power Supplies Version 3.0, September 2013”. Average efficiency level of 88% is assumed for bronze level. Silver and gold levels assumed at 1 point higher (89%); baseline level assumed at 1 point lower (87%).</p>
	<p>[criterion 4.1.5.1] Chlorine levels in baseline products are based on Cl content in PVC parts; assumed at zero for EPEAT per tech review comments on corresponding criterion for mobile phones. Bromine levels for EPEAT products are assumed at zero in circuit board resin, based on industry expert review. Due to lack ofecoinvent data on flame retardant production, the manufacture of flame retardants (brominated and non-brominated) are not included in the calculator.</p>
	<p>[criterion 4.1.10.1] Average F-GHG emissions per m2 of notebook and tablet display for best manufacturers from “Electronic Industry Citizen Coalition, 2016. Assessing and Reducing F-GHGs in the Electronics Supply Chain.” March. Accessed May 11, 2018. Baseline and bronze level assumed at average for notebook and tablet flat panel manufacturing (57 kg CO2 eq/m2 and 77 kg CO2 eq/m2). Tablet emission rate per m2 also used for displays and integrated desktop screen areas. Silver and gold assumed as a reduction from the baseline level (-8% and -39% of baseline) using phone registry data downloaded 04-24-2018 as surrogate.</p>
	<p>[criterion 4.1.10.2] Fluorinated emission (F-GHG) reduction per m2 of semiconductor manufacturing based on World Semiconductor Council. Best Practice Guidance for Semiconductor PFC Emission Reduction. May 18, 2017; adjusted based on industry expert review. Amounts of manufactured wafer input per device are based on the device models constructed from the BOMs for each device modeled in SimaPro LCA software. Baseline and bronze level servers assumed at 30% reduction over reported 2010 reference point; silver and gold EPEAT levels assumed at 90% reduction over 2010 reference point.</p>
	<p>[criterion 4.2.1.1] Post-consumer recycled plastic content in plastic parts in computer products and displays based on the minimum standard criterion 4.2.1.1 for bronze level products (2%).</p> <p>Average recycled content shown in EPEAT registry download (November 5, 2018) assumed for silver and gold level products. Silver level EPEAT desktop (5%); monitor (19%); notebook (5%); tablets: (2%); integrated desktop computer (3%). Gold level EPEAT desktop (16%); monitor (24%); notebook (5%); tablets: (2%); integrated desktop computer (32%)</p>
	<p>[criterion 4.4.1.2] Long life rechargeable battery is assumed for all EPEAT notebooks and tablets (4 year battery life). Baseline product battery life assumed at 2 years. Battery composition was assumed the same for long life and baseline batteries; benefits calculation is based on less frequent replacement of long-life batteries resulting in fewer batteries produced.</p>
	<p>[criterion 4.7.3.2] Recycled fiber in corrugated packaging is assumed at 50% for all EPEAT levels based on range shown in various manufacturer environmental product declarations; assume balance required to meet standard criterion 4.7.3.2 is sustainably sourced virgin material. Baseline level is assumed at 10% based on EPA’s WARM Version 14 documentation.</p>

	<p>[criterion 4.7.4.1] Bulk packaging is optional user data entry. Savings, based on industry data, will be applied to all EPEAT levels if user selects bulk packaging. Cartons, molded paper pulp, LDPE bags, unspecified plastics 32% reduction by weight. Transportation volume 50% reduction.</p>
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<p>Non-EPEAT (baseline) computer and display products</p>	<p>Non-EPEAT baseline computer and display products were assumed to reflect average technology, and not to meet the sustainability criteria modeled for EPEAT-registered products as outlined above. For recycled plastic content criteria, for example, the non-EPEAT product was modeled with 0% recycled content.</p>
	<p>Chlorine and bromine levels for non-EPEAT is based on Cl in weight of PVC components, and average Br level in circuit board resin is based on use of TBBPA flame retardant.</p>

Appendix B

International Energy Agency (IEA) Regional Groupings Used in the EPEAT Calculator*

1	OECD Americas*	Canada; Mexico and the United States.
2	Non-OECD Americas*	Argentina; Plurinational State of Bolivia (Bolivia); Brazil; Colombia; Costa Rica; Cuba; Curacao; Dominican Republic; Ecuador; El Salvador; Guatemala; Haiti; Honduras; Jamaica; Nicaragua; Panama; Paraguay; Peru; Suriname (from 2000); Trinidad and Tobago; Uruguay; Bolivarian Republic of Venezuela (Venezuela) and Other non-OECD Americas.
	Other non-OECD Americas	Antigua and Barbuda; Aruba; Bahamas; Barbados; Belize; Bermuda; British Virgin Islands; Cayman Islands; Dominica; Falkland Islands (Malvinas); French Guiana; Grenada; Guadeloupe; Guyana; Martinique; Montserrat; Puerto Rico ¹⁰ (for natural gas and electricity); Saba (from 2012); Saint Eustatius (from 2012); Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Sint Maarten (from 2012); Suriname (until 1999); and the Turks and Caicos Islands.
3	OECD Europe	Austria; Belgium; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Luxembourg; the Netherlands; Norway; Poland; Portugal; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Turkey and the United Kingdom.
4	China (including Hong Kong)	People's Republic of China and Hong Kong, China.
5	OECD Asia Oceania	Australia; Israel; Japan; Korea and New Zealand.

* Chile moved from OECD Americas to Non-OECD Americas

Reference: International Energy Agency. WORLD ENERGY BALANCES: DATABASE DOCUMENTATION (2017 edition). Chapter 5: Geographical Coverage. http://wds.iea.org/wds/pdf/WORLDBAL_Documentation.pdf