Sustainable Games Standard - Scope 3, Category 11

GHG emissions - Use of sold products (PC)

VERSION: 1.2.1

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Top-level summary

Emissions from:	• End-user gameplay on PCs • System components for PC gameplay (screens, audio, VR headsets, etc)

Examples:	• Gameplay on PCs for games sold on Steam
	• Gameplay on PCs combined with collected player hardware-specifications
	• Gameplay on VR headsets connected to PCs
	• Screen and audio equipment power consumption
	• **EXCLUDES**:
	  • Consideration of complex system changes from VR headset use (treats VR headsets as 100% additional energy use on top of existing system)
	  • Keyboard and mouse, controllers, flight sticks, or other peripherals

Data sources:	• Direct energy measurement from PC hardware (e.g. RAPL, Laptop battery readings, etc) – accounting for possible future capabilities • Steam hardware survey power model (maintained by SGA) • User hardware as shared in Steam reviews • Play duration data from in-game metrics, platforms, or other sources • Minimum system hardware requirements as specified by the developer
Data types:	• Player duration total (hours) • Player location (country/continent or world as fallback) • VR compatibility & play duration in VR mode • Hardware specs for minimum system requirements
Changelog	• (V1.2.1) Enhanced second methodology (Steam hardware survey based method) to allow for either low/medium/high spec hardware splits, or a single weighted average for expected PC power consumption

Consult with other SGA resources

Understanding the requirements and nature of this component of the GHG emissions standard may be aided by consulting the relevant data input spreadsheet to see the overall structure and major sections before reading the standard specification.

Overview

The SGA standard methodology for Scope 3 Category 11 "Use of sold products (PC)" aims to improve upon the advice in the GHG Protocol "direct use-phase emissions from products that directly consume energy" for games that are played on PCs. For the purposes of this Standard, PCs are any gaming device that is not considered a console or a mobile phone. At present, the PC standard focuses on the Windows platform and assumes a desktop form factor – however Steam hardware data used in this Standard includes both desktop and laptop hardware in proportion to their appearance in the Steam hardware survey.

Future versions of this component of the standard may include methodologies and guidance for Mac and Linux gaming, for gaming specifically done on laptops, or for gaming on PCs that happens outside the Steam ecosystem – contact the SGA if you wish to support the development of methods for these use cases and their inclusion in future versions of the Standard.

As in other parts of the standard, multiple methodologies are permitted for use depending on the availability of data. Three methods are permitted for measuring users on PCs. The first involves direct power measurements of PC players, taken by developers (such as via Intel's RAPL technology, or other similar systems as they become available). The second involves estimating emissions based on total player duration in a given location, combined with either collected data regarding the split of system hardware specs among players (e.g. via Steam

game reviews), or with an average expected energy consumption value from the Steam hardware survey for the Steam playerbase. The third method adopts a version of the JYROS calculator methodology of producing a hardware energy consumption profile by selecting the minimum system components required for the game (e.g. by selecting the CPU & GPU minimums listed under “system requirements” on digital storefronts). This method, however, should be considered a lower bound of energy and emissions, with a percentage of padding added to capture a more representative and more conservative estimate.

Users of the standard are encouraged to improve their data collection practices over time to enable them to move towards more accurate, real-world measurement of their players' impacts to enable interventions to reduce those impacts.

A change in this version of this component (V1.2 onwards) is the addition of a simplified method for PC player hours calculations that avoid the “low/medium/high” hardware specification splits for simplicity or where data is unavailable.

Specification

Users shall employ the following methods to measure the electricity consumption and greenhouse gas emissions arising from Scope 3, Category 11 “Use of sold products (PC)” as a result of PC gaming energy consumption. Due to the open nature of PC hardware, the great many different vendors and components resulting in many hardware combinations, and the limited degree of platform oversight, users of this Standard are expected to primarily rely on estimates over direct measurement until data collection systems improve.

System Boundaries

The basic system elements for the measurement of energy consumption and emissions from PC gameplay are:

- The device the game is being played on (i.e. the PC itself)
- An average display/screen
- An average connected speaker
- A VR headset + VR controllers (if VR compatible; to be considered in proportion to measured or estimated VR gameplay hours as a percentage of total)

Methodologies for calculating end-user energy consumption (PC)

The following three options for end-user PC energy consumption totals are permitted.

Option 1 – Measured power consumption (kWh, by location)

For this option, a studio collects location-based data (country level) that measures the direct power consumption across all its players' devices, through the use of an energy-collecting telemetry system data (e.g. Wattwiser/Intel RAPL/Nvidia power monitor) to measure usage. This method is primarily provided as an aspirational target and to guide software development initiatives that may, in future, provide such a service to the games industry.

Users of the standard will also need to collect player duration data, to apply an estimated energy consumption figure for system components besides the PC device itself, including VR headsets (and VR player duration as a percentage of total – e.g. VR exclusive titles = 100%), an average screen, and an audio device. For each location, energy consumption totals for system components are to be added to the measured PC device energy consumption.

The total energy consumption from all sources is to be multiplied by the most applicable location-based emissions factor to produce subtotals. The sum of all location-based subtotals is to be considered the total for S3.11 (PC) gameplay emissions.

Example Application of Option 1

Measured PC energy consumption$_{Denmark}$ = 5,000,000.00 kWh

Player duration$_{Denmark}$ = 20,000 hours

VR player duration$_{Denmark}$ = 5%

VR system component subtotal$_{Denmark}$ = 20,000 * 17 watts * 5%

= 17,000 Wh / 17 kWh

System component energy consumption$_{Denmakr}$ = 20,000 hours * (average screen/display (W) + average audio device (W))

= 20,000 * (92 + 30)

= 2,400,000 Wh / 2,4000 kWh

PC energy consumption$_{Denmark}$ = PC Device energy consumption (5,000,000.00 kWh) + PC system components energy consumption (2,4000 kWh) + VR energy consumption (17 kWh)

PC energy consumption$_{Denmark}$ = 5,002,457.00 kWh

PC GHG emissions$_{Denmark_2024}$ = 5,002,457.00 kWh * 143.3 (gCO2e/kWh)

= 716,852.09 kgCO2e / 716.85 tCO2e

Total PC energy consumption = ∑ (PC energy consumption$_{Location\ A}$ + … *for all locations*)

Total PC GHG emissions = ∑ (PC GHG emissions $_{Location\ A}$ + … *for all locations*)

Option 2 – Estimated consumption by player duration and (optional) player hardware split by low/medium/high spec device (hours, PC level, by location)

For this option, a studio internally collects location-based data (country level, but continent or a global figure are also permitted as a fallback) that measures the hours players play for. Where possible, studios are encouraged to collect data on the typical PC hardware profile of their players – for example from Steam user reviews with attached PC specifications – to produce an expected split of players on low/medium/high spec PCs.

To these location-based play duration figures, additional system components shall be added as in Option 1, providing for the energy consumption of an average display/screen and an average audio device. Also, as with Option 1, VR-enabled games should collect the total play duration in VR mode as a percentage of total play duration in a location, and apply the same additional energy consumption overheads for VR components (a single average energy consumption figure for HMDs/controllers/base stations – an SGA provided average).

The SGA shall maintain a database of the hardware components represented in the Steam hardware survey and their associated power consumption estimates, to be applied to estimates for the hardware capabilities and energy consumption of the average PC playerbase.

To calculate a location-based energy consumption estimate, total play duration hours are to be multiplied by either the single expected Steam user PC power consumption total derived from the SGA analysis, or by each of the low/medium/high spec PC percentage totals derived from the SGA Steam Hardware Survey analysis in proportion to the player hardware splits collected. To this, an additional energy consumption amount for both a connected average display and average audio device shall be added, by multiplying the total location-based play duration with the same energy consumption figures for these devices as in Option 1.

A location-based energy consumption subtotal shall be produced by summing the expected PC energy consumption (whether calculated via single expected Steam user PC power consumption, or via expected end user hardware spec splits), plus the consumption from additional system components. A location-based GHG emissions total shall be calculated by multiplying the location-based energy consumption subtotal with the most applicable emissions factor for that location.

A grand total of PC energy consumption shall be produced by summing the subtotals for each location.

Current expected PC Steam user power consumption figures are available based on the following historic Steam hardware survey data and SGA data collection and analysis:

Calendar Year	Weighted Avg GPU TDP (Excluding non-named GPUs) (W)	Percentage of Steam HW covered	Weighted Avg CPU TDP (W)	Percent of total market (Passmar)	Additional component overheads (10%) (W)	Average Steam Hardware TDP total (W)
2024	158.04	91.52%	90.92	70.10%	24.90	273.86
2025	169.79	91.66%	90.78	68.70%	26.06	286.62

Example Application of Option 2 Method (no player hardware split information)

Data for the following game was collected for the location Germany.

$\text{Total Player Hours}_{\text{Germany}}$ = 20,000

$\text{Total VR play duration}_{\text{Percent}}$ = 0%

$\text{Expected PC}_{\text{energy_Germany}}$ = 20,000 (hours) * 286.23 (watts)

= 5,724,600 (Wh) / 5,724.6 (kWh)

Additional system components energy consumption $\text{total}_{\text{Germany}}$ = 20,000 (hours) * (92 watts + 30 watts)

= 2,440,000 (Wh) / 2,440 (kWh)

$\text{Total PC}_{\text{Energy_Germany}}$ = 8,164.6 kWh

$\text{Total PC}_{\text{GHG emissions_Germany_2024}}$ = 8,164.6 kWh * 344.14 (g CO2e/kWh)

= 2,809,765.444 (g CO2e) / 2,809.77 (kg CO2e)

Total PC energy consumption = ∑ (PC energy consumption$_{\text{Location A}}$ + … *for all locations*)

Total PC GHG emissions = ∑ (PC GHG emissions $_{\text{Location A}}$ + … *for all locations*)

Example Application of Option 2 Method (including low/med/high player hardware split)

Data for the following high-intensity AAA game was collected for the location Germany. (Note that in this example, the total player hardware totals do not sum to 100% owing to a small percentage of PC users playing on Steam deck)

Total Player Hours$_{\text{Germany2025}}$	= 20,000
Total VR play duration$_{\text{Percent}}$	= 0%
Steam players hardware low$_{\text{Percent}}$	= 8.40%
Steam players hardware medium$_{\text{Percent}}$	= 32.40%
Steam players hardware high$_{\text{Percent}}$	= 58.20%

Expected PC low$_{\text{energy_Germany2025}}$	= 20,000 (hours) * 121.32 (watts) * 8.40%
	= 203,817.6 (Wh) / 203.82 (kWh)
Expected PC medium$_{\text{energy_Germany2025}}$	= 20,000 (hours) * 248.35 (watts) * 32.40%
	= 1,609,308 (Wh) / 1,609.30 (kWh)
Expected PC high$_{\text{energy_Germany2025}}$	= 20,000 (hours) * 458.43 (watts) * 58.20%
	= 5,336,125.2 (Wh) / 5,336.13 (kWh)

Total PC$_{\text{Energy_Germany2025}}$	= 203.82 kWh + 1,609.30 kWh + 5,336.13 kWh
	= 7,149.25 kWh
Total PC$_{\text{GHG emissions_Germany2025}}$	= 7,149.25 kWh * 344.14 (g CO2e/kWh)
	= 2,460,342.895 (g CO2e) / 2,460.34 (kg CO2e)

Total PC energy consumption = ∑ (PC energy consumption$_{\text{Location A}}$ + … *for all locations*)

Total PC GHG emissions = ∑ (PC GHG emissions $_{\text{Location A}}$ + … *for all locations*)

Option 3 – JYROS method – (minimum system requirements, player hours, by location)

For this method, a studio builds a simplified profile of the minimum system specifications PC required for play of their game as a 'baseline' expectation for the minimum baseline energy consumption and emissions from play. This expected minimum system energy consumption figure is then combined with either total player hours (by location) or sales numbers/play duration assumptions (also by location) to produce an estimate for minimum energy consumption from play on PC.

As the main power-consuming components of a PC, a hardware profile is to be produced by selecting from a database of CPU and GPU components to approximately reflect the minimum specifications as communicated in the game's sales material. For example: if a game's system requirements for CPU states that it requires an AMD Ryzen 5 1600 or Core i5 6600K, then one of these components is to be selected from the database as the minimum CPU specification, and the relevant component thermal design power figure used as an approximate measure of the components power use. The same process shall apply for GPUs.

The TDP totals for both CPU and GPU components are to be summed. To this, an additional internal components overhead of 10% is to be added to account for various other components such as motherboard, RAM, SSD/HDD storage, networking, etc. This total shall be considered a single power consumption figure for the minimum specification system that is to be multiplied by the total play duration (in hours) in each location, to produce a location minimum power consumption figure. As in Options 1 & 2 before, an allowance for the energy consumed by the typical screen/display and audio device shall also be added, by multiplying the energy consumption of these system components (screen 92 W, audio 30 W) with the total player duration in the location. The sum of these two energy consumption figures shall be the location energy consumption subtotal.

This location energy consumption subtotal shall be multiplied by the most appropriate location-based emissions factor to produce a location GHG emissions subtotal. The sum of all location GHG emissions subtotals shall be considered the total minimum expected energy consumption for S3.11 use of sold products (PC).

Example System Specification for Baseline Energy Consumption

SET MINIMUM SPECS – GAME 1 NOTE: Pick only Intel OR AMD CPU, do not select both			Expected Minimum System Specs Total (Watts)
GAME NAME	Test 1		198
	Component Name		Power (W)
Intel CPU			
AMD CPU	AMD Ryzen 5 3600		65
GPU	NVIDIA GeForce RTX 4060		115
Rest of system overhead (10%)			18

Example Data Input for Player Duration (by location) and VR play duration percentage

Game	Location (country as 1st preference, use continent, region, or world only as last resort)	Location EF (automatic) (gCO2e per kWh)	Total player hours in Region	%age play duration time in VR (If title is VR exclusive = 100%, if no VR = 0%)
Test 1	Australia	551.59	20,000.00	50%
Test 1	France	44.18	20,000.00	0%
Test 1	Finland	72.25	20,000.00	0%
Test 1	Denmark	143.3	20,000.00	0%

Example Calculations from Player Duration (by location) and VR play duration percentage using the specified system minimum requirements

VR headset overhead (W) (12 W HMD + 5W controllers)	Minimum Device Spec expected power	Device Power Consumption (kWh)	VR power consumption (kWh)	Display – 92W (kWh)	Audio – 30W (kWh)	Device Emissions (kg CO2e)	System Emissions (kg CO2e)	Subtotals (kg CO2e)
17	198	3,960	170	1840	600	2184.2964	1439.6499	3623.9463
17	198	3,960	0	1840	600	174.9528	107.7992	282.752
17	198	3,960	0	1840	600	286.11	176.29	462.4
17	198	3,960	0	1840	600	567.468	349.652	917.12

Total Reportable Scope 3 Category 11 (PC) emissions

The reportable results for Scope 3 Category 11 (PC) emissions will be the sum of the results of the chosen method for calculating emissions, plus the results of the Multiplayer Module if the game is multiplayer and gameplay requires or involves internet data transmission between end user client and a “server” (including P2P multiplayer, where another player is simply the “server”).

Description of SGA Steam hardware power model

The following data is collected each year (in January) from the Steam hardware survey, and considered to apply as the most representative period covering the previous year's activity:

- The popularity of GPUs present in the Steam hardware survey (as a percentage)
- The popularity of CPUs as present in the Passmark CPU benchmark survey (covering the previous 30 days)

These devices are combined with a database of TDP (thermal design power) values, and a weighted average TDP values for an average Steam user GPU and CPU are generated. These are summed, and increased by an additional 10% to account for other system components that draw power, including RAM, motherboard, storage and cooling. In future, we aim to more accurately model these other smaller components.

A consequence of using a single "average" Steam user hardware figure is to overestimate the energy consumption and emissions of lower intensity games (e.g. 2D games, indies, etc) and to underestimate the same for higher intensity graphical and computational games (AAA titles, cutting-edge games, etc).

To enable greater accuracy, expected Steam power profiles for low, medium and high spec PC devices are also produced, following the same data collection process for the Steam average user profile. Components are manually bucketed into low/medium/high power profiles. Current values for low/med/high spec power profiles (including the same 10% overhead) are as follows:

Year	Low total (inc 10% overheads) (W)	Med total (inc 10% overheads) (W)	High total (inc 10% overheads) (W)
2024	122.38	248.13	452.14
2025	121.32	248.35	458.43

Appendix – References and Equations

Resources that have informed this draft:

- GESI ICT Sector Guidance for measuring software energy consumption (Ch6)

GHG Protocol Direct use-phase emissions method, for reference:

Calculation formula [11.1] Direct use-phase emissions from products that directly consume energy (fuels or electricity) during use

CO_2e emissions from use of sold products =

sum across fuels consumed from use of products:
∑ (total lifetime expected uses of product × number sold in reporting period
× fuel consumed per use (kWh) × emission factor for fuel (kg CO_2e/kWh))
+
sum across electricity consumed from use of products:
∑ (total lifetime expected uses of product × number sold in reporting period
× electricity consumed per use (kWh) × emission factor for electricity (kg CO_2e/kWh))
+
sum across refrigerant leakage from use of products:
∑ (total lifetime expected uses of product × number sold in reporting period
× refrigerant leakage per use (kg) × global warming potential (kg CO_2e/kg))

Total Reportable Emissions Sum Equation

None

TBC