

Information Technology

Information and Communication Technology (ICT) includes personal and business computers and smartphones, data centers, connectivity networks, and emerging technologies such as artificial intelligence (AI) and cryptocurrency. The ICT sector continues to expand, using more energy and water resources, which presents challenges to achieving global climate goals.¹

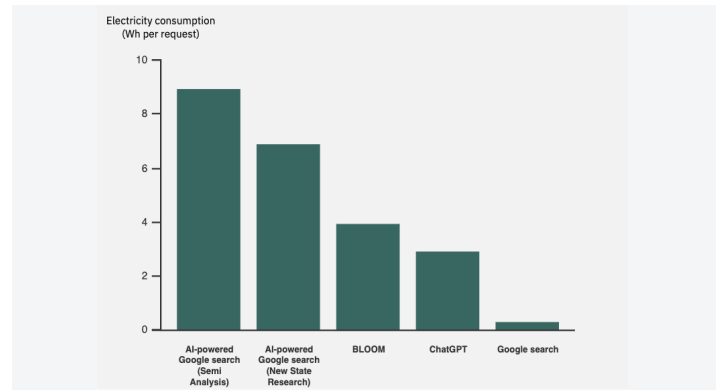
Patterns of Use

- 5.4B people (67% of the world’s population) are online, an increase of 45% since 2018.²
- In 2022, 1.8B mobile phones, tablets, and PCs were sold worldwide, an 11.9% decline from 2021.³ Global smartphone sales peaked at 1.6B units in 2018 and decreased to 1.4B units by 2022.⁴ Globally, more people have mobile phones than access to safe sanitation.^{5,6}
- In 2021, 90% of U.S. households had a smartphone, 81% had a desktop or laptop computer, 64% owned a tablet, and 90% had a broadband internet subscription.⁷
- In 2022, 33% of 8,000 global data centers were located in the U.S., 16% in Europe, and 10% in China.⁸ Virginia, Texas, and California accounted for 43% of 2023 U.S. data center load.⁹
- Data center electricity demand is 40% from computing, 40% from cooling, and 20% from other IT equipment.⁸
- Regional transmission organization PJM, serving eastern U.S., expects data centers to drive an increase in summer peak electricity load from 151 GW in 2024 to 178 GW by 2034.⁸
- Power Usage Effectiveness (PUE) quantifies a data center’s energy efficiency by dividing the total energy used by the energy used by IT equipment alone. The U.S. average annual PUE declined from 2.5 in 2007 to 1.6 in 2023.⁹

Energy and Environmental Impact

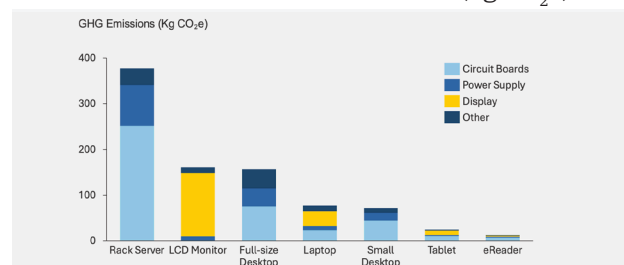
- Computer electricity consumption varies greatly with age, hardware, and user habits. An average desktop computer requires 66 W (idle) and 1.9 W (asleep). Laptops require 33 W (idle) and 1.0 W (asleep).¹¹ A 17” LCD monitor uses 13 W while on, 0.4 W in standby, and about 0.3 W when off.¹¹
- Each ChatGPT request is estimated to use 2.9 Wh of electricity, while a standard Google search uses 0.3 Wh.¹²
- Each kWh used by office equipment requires additional 0.2-0.5 kWh for air conditioning.¹³ Office equipment made up 13% of electricity use (227B kWh) in office buildings in 2018.¹⁴
- The life cycle energy burden of a typical computer used for 3 years is 4,222 kWh, with 34% from the use phase.¹⁵ Manufacturing represents 60-85% of life cycle energy

Estimated Electricity Use Per Request (Wh/request)¹²



- demand for a personal computer and 50-60% for mobile phones. Remanufacturing energy is 5-30% of manufacturing energy for personal computers and 5% for mobile phones.¹⁶
- Globally, the ICT sector used 1,183 TWh of electricity in 2022, up 8.2% from 2020, with data centers increasing the most.¹ Electricity used for AI, cryptocurrency, and data centers could double by 2026 to over 1,000 TWh.⁸
- Data centers used 240-340 TWh of electricity, or 1-1.3% of global electricity use in 2022.¹⁷
- U.S. data centers used 150 TWh of electricity in 2023, 4% of electricity use, equivalent to the annual use of 14M average households. Data centers used 26% of Virginia’s electricity in 2023, the highest among U.S. states.⁹
- Cryptocurrency mining was estimated to use 67 TWh to 240 TWh of electricity globally in 2023, and 0.6% to 2.3% of electricity in the U.S.¹⁸
- The ICT sector’s global carbon emissions were estimated to be 567 Mt CO₂e in 2022, 1.7% of the world total.¹ Estimated annual GHG emissions from cryptocurrency mining were 73 Mt CO₂e in 2023.¹⁹ Electricity use in U.S. data centers results in 56.3 Mt CO₂e emissions annually, 0.9% of the U.S. total.^{9, 20, 21}
- The data center boom has increased carbon emissions for tech companies²² - at Google by almost 50% from 2019 to 2023²³ and at Microsoft by nearly 30% since 2020.²⁴
- Data centers are among the top ten commercial/industrial U.S. water users. The operational water footprint of data centers in 2018 was 135.5B gal/yr, with 75% attributed to electricity and 25% to onsite use. One-fifth of the data center onsite use occurs in water stressed regions, while nearly half of data centers use electricity from water stressed regions.²⁵

GHG Emissions for Electronic Products (kg CO₂e)²⁶



ICT Sector GHG Emissions and Electricity Use¹

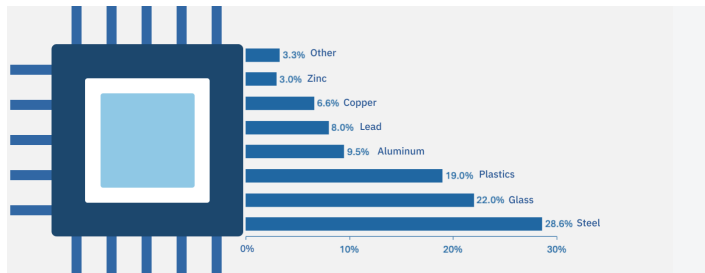
Industry	Emissions (million tCO ₂ e)				Electricity (TWh)			
	2020	2021	2022	2020 - 2022 % Change	2020	2021	2022	2020 - 2022 % Change
Telecommunications operators	135	134	133	-1%	239	255	258	8%
Data Centers	58	67	75	29%	143	170	194	36%
ICT Equipment	154	173	154	0.5%	282	329	311	10.6%
Product use	222	215	205	-7.5%	430	442	430	-0.1%
Total	568	589	567	-0.2%	1,094	1,196	1,183	8.2%

¹Data centers include Colocation, and Cloud & content data centers reported by companies.
²ICT Equipment refers to the manufacturing of PCs, smartphones and network equipments.
³Product use is the use phase of PCs and smartphones.

Electronic Waste

- In 2022, 62 Mt of e-waste was generated globally, 22% of which was recycled. This waste would fill 1.5M 40 t trucks.²⁸
- An estimated 5-30% of 40M computers used in the U.S. were exported to developing countries in 2010.²⁹ In 2016, 34% of the e-waste tracked by GPS trackers in the U.S. moved offshore, mostly to developing countries.³⁰
- In 2018, the U.S. disposed of 2.7M tons of consumer electronics, 39% of which were recycled.³¹
- The main constituents of printed circuit boards used in mobile electronics are polymers and copper, with trace amounts of precious metals Ag, Au, and Pd, and toxic metals As, Be, Cr, and Pb.³²
- 1 t of printed circuit boards has a higher concentration of precious metals than 1 t of mined ore.³³

Material Composition of a Desktop Computer²⁷



Paper Industry

- In 2022, global paper and paperboard production fell slightly from 418 Mt in 2021 to 414 Mt. China is the largest producer, accounting for 31% of the world total in 2022, followed by the U.S. with 16%, or 65 Mt, a 12.7% decline from 2012.³⁴
- Annual use of paper is expected to rise from 109 to 274 Mt between 2006 and 2060.³⁵ The U.S. used approximately 18% of paper globally.³⁶
- Depending on the process, producing one ton of paper uses 12 to 24 trees.³⁷
- In 2022, GHG emissions of the U.S. pulp and paper industry were 31.2 Mt CO₂e,³⁸ approximately equivalent to the annual carbon sequestered by 36M acres of forest.³⁹

Sustainable Alternatives

Technology

- AI applications in sustainability include optimizing energy and natural resources, grid management, informing disaster response, climate modeling, ecological forecasting, etc.⁴⁰
- Virtualization enables one physical server to run many independent programs and/or operating systems⁴¹, reducing the number of physical servers needed and promoting greater utilization of each server⁴², saving money while reducing the environmental burdens of running a data center⁴³.
- Data center energy efficiency can be improved by using combined heat and power systems. Heat recovered from electricity generation in the form of steam or hot water can be used by an on-site chiller to cool the data center.⁴⁴
- 3D printing has the potential to reduce 5–27% of global energy use in 2050.⁴⁵
- Telecommuting, or working from home, can save energy from decreased transportation, though savings are partially offset by increased energy use for IT, lighting, and heating/cooling.⁴⁶ This has resulted in a 13% reduction in work-related energy use and a 14% reduction in GHG emissions in response to COVID in 2020 across the U.S.⁴⁷

Take Action

- The ICT sector accounted for 60% of renewable power purchases in 2021.¹
- Choose [Energy Star certified office equipment](#). The [Electronic Product Environmental Assessment Tool \(EPEAT\)](#) rates the environmental impacts of computer products. If all servers in the U.S. met Energy Star standards, \$1B in energy would be saved and 8.2 Mt of GHG emissions would be avoided yearly.⁴⁸
- Energy used by devices in standby mode accounts for 5-10% of residential energy use. Unplug electronic devices when not in use, or plug them into a power strip and turn that off.⁴⁹ Turning off a computer when it is not in use can save 505 kWh, \$50, and 433 lbs of CO₂ per computer annually.^{20, 50}
- EPA recommends setting computer monitors to go to sleep after 5-20 minutes of inactivity, and setting desktop computers to stand by after 30-60 minutes.⁵¹
- Avoid unnecessary printing and print double-sided on recycled paper if necessary.⁵²
- Extend the life of personal computers to delay the energy and materials burdens associated with making new equipment.¹⁶
- Maximize the life of batteries by minimizing exposure to extreme temperatures and time spent at both 0% and 100% charge; avoiding fast charging and discharging.⁵³
- Recycle your unused electronics. [Responsible Recycling \(R2\)](#) and [e-Stewards](#) offer third-party certification for electronics recyclers to ensure the proper disposal of used electronics.⁵⁴