Energy Consumption of Consumer Electronics in U.S. Homes in 2024

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ABSTRACT

We conducted a study to quantify the electricity consumption of the dynamic consumer electronics (CE) end use in U.S. households in 2024. As in five prior studies of CE energy consumption by the authors, we took a bottom-up approach to estimate the energy consumption of individual device categories based on their installed base, typical annual usage by mode, and power draw by mode. We fielded two surveys to a demographically representative sample of U.S. households to understand the installed base and usage patterns of televisions, computers and their monitors, video game consoles, and other devices. The survey responses served as inputs into more detailed energy use models for priority devices. We estimate that 3 billion consumer electronics devices consumed about 153 TWh in 2024, equal to about 9.9% of residential sector and 3.5% of total U.S. electricity consumption. Collectively, the devices studied in more depth accounted for about 80% of total CE AEC (annual electricity consumption), with televisions, the highest consuming category, representing 36% of the total. The combined AEC of the next five devices as ranked by AEC, i.e., desktop computers and their monitors (14%), network gateways (10%), video game consoles (8%), and subscription set-top boxes (6%), is similar to that of TVs. Relative to 2020, total CE energy consumption decreased by 23 TWh, or about 13%. The decrease mainly reflects large decreases in the AEC of desktop computers (10 TWh, -38%), monitors (6 TWh, -52%), subscription set-top boxes (7 TWh, -43%), and notebook computers (4 TWh, -43%).

Introduction

This paper shares findings from a comprehensive study of U.S. Consumer Electronics (CE) energy use in 2024 (Urban and Roth 2026). The study, the sixth of its kind (Roth and McKenny 2007, Urban, Tiefenbeck, and Roth 2011; Urban, et al. 2014; Urban, et al. 2017, Urban, Roth, and Olano 2021), provides an in-depth characterization of the ownership, power draw, and usage of electronics, providing energy policymakers and industry stakeholders with current information.

CE encompass a wide variety of devices, like computers, monitors, video games, and televisions, used in homes. Relative to other end uses, consumer electronics typically change quickly due to rapid innovation, short product cycles, rapid adoption, and evolving usage patterns. As a result, the installed base or usage of product categories can shift appreciably in a matter of years. For example, the 2020 study (Urban et al. 2021), found large spikes in usage owing to pandemic effects. As people spent more time at home, televisions, computers, monitors, and video game usage increased dramatically. In this study, we explore how those trends in usage have evolved in the aftermath.

Owing to potentially rapid and significant changes in CE energy consumption, the Consumer Technology Association (CTA®) commissioned this and prior studies to develop up-to-date and accurate energy characterizations. If policymakers rely on obsolete data, the resulting programs could be less likely to achieve intended goals. Consequently, we performed this study to provide current, high-quality data to inform CE energy policy decisions.

This paper focuses on the study methodology, key results and noteworthy trends. The Final Report for this study (Urban and Roth 2024) describes the methods, results, and modeling decisions for individual device categories in much greater detail.

Methods

Device Selection

To balance accuracy and precision with available resources, we focused our effort on analyzing devices where a more refined analysis would yield the greatest impact. Specifically, we prioritized our effort based on preliminary annual electricity consumption (AEC) estimates, selecting the following devices with a higher AEC and/or greater AEC uncertainty for more detailed study:

- Computers, Desktop
- Computers, Portable
- Computer Monitors
- Small Network Equipment Gateways
- Small Network Equipment, Local Equipment
- Set-top Boxes, Standalone DVR
- Set-top Boxes, Streaming Media
- Set-top Boxes, Subscription
- Set-top Boxes, OTA DTA
- Televisions
- Video Game Consoles (major)

We studied the remaining 45 device categories in relatively less depth, as they have less impact on top-line estimates. Historically, this approach has worked well, since relatively few devices account for the bulk of total CE energy consumption, i.e., in the current study the priority devices selected for in-depth study accounted for about 80% of total CE AEC.

Although we did not study the "other" devices in as much detail, we did review the values used in our prior CE studies to estimate their UEC (unit energy consumption) and AEC. We identified several devices where usage data were outdated or poorly established, and made reasonable assumptions or revisions. In other cases, we updated power values based on readily available data or measurements. The Final Report includes the methodology, values, and sources used to characterize all 45 "other" devices.

Energy Modeling Approach

We used a bottom-up modeling approach to evaluate consumer electronic device energy consumption, see Figure 1. For each device category studied, we developed estimates for the typical average power draw (W) and usage (hours per year) in relevant power modes. The product of the power draw and usage by mode yields the component unit energy consumption (UEC, in kWh per year) values, and the sum of UEC over all modes equals the total device UEC. Finally, the product of the total device UEC and the installed base (in millions of units) equals the annual electricity consumption (AEC, in TWh). The prior CE studies followed similar methods (Roth and McKenney 2007; Urban, Tiefenbeck, and Roth 2011; Urban et al. 2015; Urban et al. 2018; Urban, Roth, and Olano 2021; and Urban and Roth 2026). The power modes shown in Figure 1 are illustrative and we tailored them for each device category in the analysis; Urban and Roth (2026) explains the models used for each device category in depth. A succinct overview of the model components follows.

Mode	Power Watts		Usage hours/year		Unit Energy Consumption kWh/year		Installed Base million units	Annual Energy Consumption TWh
Active	P_{active}	×	T_{active}	=	UEC_{active}			
Sleep	P_{sleep}	×	T_{sleep}	=	UEC_{sleep}	**$\sum$ = UEC_{total}**	**× IB**	**= AEC**
Off	P_{off}	×	T_{off}	=	UEC_{off}			

Figure 1. Illustrative method for calculating device-level Unit and Annual Energy Consumption.

Installed Base. The installed base represents the total number of devices in U.S. households that were plugged in at least once during the past month. Intentionally, this excludes devices that are owned but not plugged in. Consistent with CTA Market Research’s estimates (CTA 2024), we assume 126 million U.S. households in 2024. Most installed base estimates came from market research studies: most notably ownership and sales reports from CTA, the CE Usage Survey (see Appendix A), and, to a lesser extent, other sources of ownership and sales data. For most devices, the installed base estimates have the lowest uncertainty of any AEC component.

Power Draw by Mode. Most consumer electronics have at least two distinct power modes, on/active and off. Many have additional intermediate modes such as idle, standby, sleep, hibernate, or charging. Within modes, device power draw may vary due to changes in operation or workload, such as variable processor utilization, display resolution or brightness levels, and audio levels. For each device category, we identified the most relevant power modes and developed estimates for the average power draw of its installed base in each mode, attempting to reflect real-world use scenarios as well as possible.

While long-term and large-scale field measurement campaigns in hundreds of demographically representative homes might provide deeper insights into the real-world power draw of devices, such studies are expensive, slow, and face several significant real-world challenges. Given study constraints, we relied on other sources to estimate power draw by mode, including:

- Energy consumption characterization studies;
- Field measurement campaigns;
- Public product power draw databases (ENERGY STAR®, California Energy Commission [CEC]);
- Targeted measurements by Fraunhofer USA; and
- Measurements by CTA member companies.

Usage by Mode. For most devices, the average time spent per year in each specific power mode is the most challenging element to estimate accurately. Ideally, usage estimates would be based on sustained field measurement campaigns that record the time devices spent in different modes.

To provide accurate results, such studies would need a sample of at least several hundred demographically representative U.S. households, measured for weeks or months at a time, with measurements randomly distributed across an entire year. Since such studies are rare, we used other sources and methods to estimate usage by mode, including:

- The Consumer Electronics (CE) Usage Survey (described below);
- Data from prior field measurement campaigns[1]; and
- Data from prior energy consumption characterization studies.

Consumer Electronics Usage Survey

To characterize the installed base, device characteristics, and user behavior for several different CE devices, we worked with CTA Market Research to create an online survey of a demographically representative sample of households, hereafter referred to as the CE Usage Survey. The survey addressed the priority device categories noted above, including televisions, computers (and associated devices), monitors, and video game consoles. For some devices, like televisions, we asked detailed questions about the device itself, such as approximate screen size and display type. This is important because past (and the current) CE energy consumption studies have found that use can correlate with features affecting energy consumption, including screen size, vintage, and display type. That is, the most-used TV in homes is, on average, newer and larger than the second-most used TV. We also posed questions about several other devices where we lacked credible, recent installed base estimates and/or usage data. Table 1 summarizes the devices included in the 2024 CE Usage Survey.

Table 1. Devices included in the CE Usage Survey

Devices Studied in More Depth	**Other Devices Studies in Less Depth**
Computers, Desktop	Clock Radios
Computers, Portable	Compact Shelf Stereos
Computers, Monitor	Computer Speakers
Small Network Equipment (SNE), Wi-Fi modem	Cordless Phones
SNE, Wi-Fi Router	Portable Battery Banks
SNE, Wi-Fi Range Extenders	Record Players with Turntables
Televisions	Smart Speakers
	Speaker Docks
	Tablet Computers
	Video Cassette Recorders
	Wireless Chargers

As in past CE Usage surveys, we designed usage questions to estimate how many hours a device spends in different power modes. For simpler devices, we asked direct questions about usage frequency and duration. For more complex devices, such as computers and monitors, we posed additional questions to identify likely power management settings and used the response to

[1] Although useful, prior field measurement campaigns usually fall short of the ideal described due to a limited and often biased (i.e., non-random and unrepresentative) sample of households used and devices measured.

infer user behaviors and device states. Ultimately, we then used that information to model devices' energy consumption.

Other energy researchers have raised questions about the validity of survey responses, e.g., Desroches, Greenblatt, and Pratt (2013) raised the possibility of skewed responses due to recollection bias and social desirability bias, the latter denoting respondents will answer questions in a way seen as more desirable by their peers. To address that, we asked questions in ways that we thought respondents would perceive as more neutral. For example, to ascertain computer overnight status, instead of asking "What do you do when you finish using the computer for the day?" (since people may think they *should* turn off their computers), we asked respondents to "Recall a time when you were the first person of the day to use the desktop computer. Which of the following best describes this computer as you found it." Similarly, although we ultimately want to know the number of hours respondents used a computer for an entire year or week, we asked them about their usage *yesterday*, since CTA Market Research personnel indicated that respondents would most accurately recall what they did yesterday. Although a respondent's usage yesterday will often *not* be representative of their specific typical daily usage over the year, the *distribution* of the responses of the population of *all* ~2,000 respondents should be representative of the overall population (once the demographic weights of each respondent are taken into account).

Two independent surveys were fielded sequentially over several weeks in November and December of 2024; the primary survey in November 2024 include responses from 2,043 households[2] and covered all product categories. The survey provider, Illuminas, used industry-standard sampling methods to deliver a representative panel of U.S. households via an online survey. Illuminas invited U.S. consumers from research panels to respond to the survey in proportions representative of the demographics of the U.S. population. While the surveys were open, Illuminas monitored the demographics of respondents and adjusted the panel as needed.

For quality control, Illuminas applied industry standard and proprietary measures to reject questionable or inauthentic responders. Examples include rejecting those who complete surveys too quickly, those who fail certain logic tests, or those who fail to respond correctly to specific attention-based test questions. In addition, the authors performed a limited post-survey data review and cleanup task to remove inauthentic responses for selected analysis. For example, data cleanup for video game consoles excluded the 6% of respondents who reported owning more than 10 consoles. These respondents generally reported owning several of each possible console, which would have artificially inflated the installed base. Data cleanup for TVs involved removing 3% of responses, mostly due to unrealistic active viewing time (exceeding 20 hours per day). In both cases, we re-weighted the balance of responses prior to data analysis.

Ultimately, we incorporated the survey results in device-specific models for usage the energy consumption of devices in households. The final report contains further details, including survey question wording and how we incorporated responses into device-specific modeling methods (Urban and Roth, 2026).

[2] Assuming that the population of survey respondents is representative, the survey sampling uncertainty varies with the inverse of the square root of the sample size. Thus, the survey sampling error is on the order of 2-3 percent for very common CE devices and will be higher for devices with lower penetration. As discussed throughout the study, there are multiple sources of uncertainty in characterizing CE energy consumption, and survey sampling error is likely appreciably smaller than other sources of uncertainty in our energy consumption estimates (with the potential exception of devices with very low penetration).

Energy Consumption Results

Total Annual Energy Consumption and Overall Trends

We estimate that 3 billion consumer electronic devices in U.S. homes consumed 153 TWh in 2024 (see Figure 2), equal to about 9.9% of residential and 3.5% of total U.S. electricity consumption.[3] Powering these devices costs U.S. consumers about $25 billion annually. For the average household, this equals about 1,215 kWh or $200 per year.[4] The 2024 energy estimate is about 13% less than for 2020 and 7% higher than the 2017 total (Urban et al. 2017, Urban, Roth, and Olano 2021).

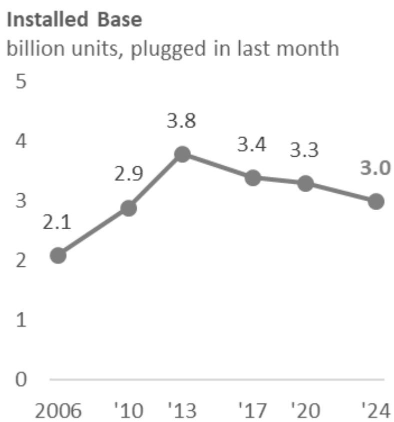

Figure 2. Residential consumer electronics installed base and energy consumption trends over the six studies. *Sources*: Roth and McKenney (2007), Urban, Tiefenbeck, and Roth (2011), Urban et al. (2015), Urban et al. (2018), Urban, Roth, and Olano (2021), and Urban and Roth (2026).

The 24 TWh decrease in total CE energy consumption from 2020 to 2024 mainly reflects large decreases in the AEC of four devices: desktop computers (10 TWh, -38%); monitors (6 TWh, -52%); subscription set-top boxes (7 TWh, -43%); and notebook computers (4 TWh, -43%). Of the categories studied in more detail, only small network equipment had an appreciable increase in AEC (3 TWh, +21%).

Device-level Consumption and Trends

Table 2 summarizes the energy consumption characteristics for all the devices analyzed in more detail. Collectively, those account for about 80% of the total consumer electronics AEC. Televisions remain the highest consuming category, representing about 36% of total CE AEC. This is similar to the combined AEC of the next five devices as ranked by AEC, i.e., desktop computers and their monitors (14%), network gateways (10%), video game consoles (8%), and subscription set-top boxes (6%).

[3] Based on U.S. electricity consumption of 1,483 TWh residential and 4,309 TWh total in 2024 (EIA 2025a).
[4] Based on the average residential price of electricity: $0.1648 per kWh for 2024 (EIA 2025b).

Table 2. Energy use estimates for consumer electronics in U.S. homes in 2024.

Device	Units, mill.	UEC, kWh/yr	AEC, TWh	Power, W *Active*	*Idle*	*Sleep*	*Off*	Usage, hours/year *Active*	*Idle*	*Sleep*	*Off*
Computers, Desktop	69	235	16.3	51	34	2.2	0.8	1,445	4,645	1,195	1,475
Computers, Portable	116	42	4.9	14	5.4	0.8	0.3	1,242	4,086	1,760	1,672
Computers, Monitor	94	55	5.2	16	-	0.4	0.2	3,235	-	3,820	1,705
Network, Gateways	116	128	14.8	-	15	-	-	-	8,760	-	-
Network, Local Equipment	61	62	3.8	-	7.1	-	-	-	8,760	-	-
Set-top Boxes, Standalone DVR	2	91	0.2	12	-	9.0	-	4,200	-	4,560	-
Set-top Boxes, Streaming Media	89	16	1.4	3.4	-	1.4	-	1,925	-	6,835	-
Set-top Boxes, Subscription	109	79	8.6	10	-	8.3	-	5,110	-	3,650	-
Set-top Boxes, OTA DTA	7	29	0.2	6.5	-	0.8	-	3,940	-	4,820	-
Televisions	245	223	54.7	98	-	3.5	-	2,038	-	6,722	
Video Games, Major Console	96	127	12.1	96	-	4.4	0.4	1,150	-	3,410	4,200
Other Devices	2,039	15	30.7								
GRAND TOTAL	**3,042**	**50**	**153**								

Note: Modes shown in this summary table are approximate; see Urban and Roth (2026) for further detail about device-specific modes.

Figure 3 shows the estimated breakdown of UEC and AEC by mode for the main categories of devices studied in more detail. As in prior studies, active and idle modes accounted for most of the consumption – about 85% of total AEC – with sleep and off/standby accounting for 12% and 3% respectively. The breakdown of total AEC by mode did not change significantly from 2020.

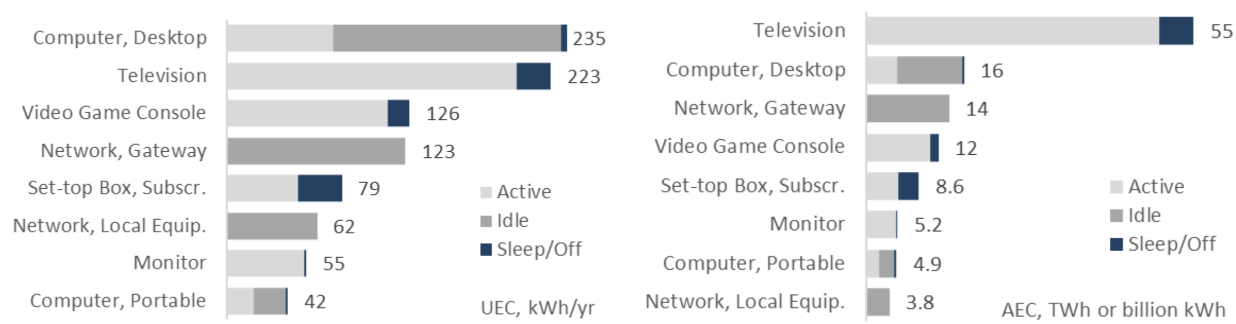

Figure 3. Unit and annual energy consumption estimates by mode for selected consumer electronics in 2024.

A discussion of specific characteristics and trends for the categories with the highest AEC follows. The full report (Urban and Roth 2026) goes into greater depth for all devices studied in greater detail, including comparisons of our results to those from other studies characterizing CE energy consumption.

Televisions (TVs). Televisions in 2024 consumed an estimated 55 TWh or 223 kWh per unit. The AEC did not change meaningfully from 2024, with a higher UEC due to higher active power draw (from larger reported screen size, 49 inches versus 41 in 2020; Urban, Roth, and Olano 2021) offset by a 40 million (14%) decrease in the installed base. On-hours per television were similar to 2020 estimates, suggesting that the increase in usage seen in 2020 may be here to stay. However, the total TV hours *per household* have declined due to the lower installed base.

We used data from the CEC appliance database to characterize TV active-mode power draw for recent-vintage TVs. Prior studies have found that TV active mode power draw and energy consumption is highly sensitive to user-selectable settings, like screen brightness or display mode (Horowitz et al. 2015, Urban et al. 2017). For example, the average power draw ratio of retail (i.e., high brightness) to default mode for 2014-2020 vintage LCD TVs in the CEC appliance database is 1.33 (CEC 2020). To address this, we applied a +12% active-mode power adjustment factor relative to the as-tested standard dynamic range (SDR) mode power draw. If this adjustment factor were 15% higher or lower (e.g., -2% or +27%), the TV AEC would change by almost 7 TWh (range: 48 to 62 TWh). The magnitude of this potential effect provides motivation for research to better understand the actual distribution of user-selectable TV settings.

TV standby energy consumption also has appreciable uncertainty, so we also studied it in further depth. Smart televisions may offer active standby modes that stay connected, start up more quickly, or wake from a smartphone, smart speaker, or voice command. These features, when enabled, may increase TV power draw substantially, by 1 to 20 W or more on certain models; however, testing has found that some models can deliver these features efficiently (Horowitz, Hardy, and Tian 2019; Hardy 2021-2025).

We considered several sources to estimate active standby power.[5] For energy labeling purposes, the U.S. Department of Energy maintains a database with power draw data for over 6,000 TV models (2024). About 30%[6] of the models in that database report a standby power greater than 1 W, likely corresponding to active standby. Across those models, the *active standby* power averaged about 7.1 W (range: 1 W to 61 W). Aggregating TV models by manufacturer and weighting by their approximate current U.S market share (Statista 2024), we estimate an average of 4.9 W active-standby power draw that we applied to the 70% of TVs that were reported as smart and connected.[7] For other TVs, we used passive standby values from EnergyStar and California Energy Commission (CEC) databases.

Computers and Monitors. We estimate that computers and their monitors consumed a total of about 26 TWh in 2024, with computers accounting for around 80% of the total. This represents more than a 40% decrease from the estimated 45 TWh consumed by those devices in 2020, with monitors (52%), notebooks (46%), and towers (44%) exhibiting the largest decreases.

Foremost, the AEC decrease was driven by large drops in estimated computer and monitor average power draw in active and idle modes. For computers, these decreases come with an important caveat related to the real-word adjustment factors we applied to reported ENERGY STAR short and long idle test values to estimate the actual active, short idle, and long idle power draw. These factors were based on testing from nearly a decade ago, and it is unclear how well they represent the current stock.

Self-reported *active* usage appears to have declined by about 40% for desktops and portables relative to 2020, aligning more closely with pre-pandemic levels. The survey used to model 2020 usage was fielded during the height of the pandemic, so it understandably found

[5] See Urban and Roth (2026) for additional details.
[6] The other 70% of TV models in the database averaged standby power of about 0.4 W, similar to passive standby from other sources.
[7] CE Usage Survey found that 82% of TVs have smart features available, with 85% of those connected to a network, i.e., 70% of all TVs are smart AND connected.

increased time using technology at home. Despite the sharp decline in user-reported active usage in 2024, the estimated total time spent in *all* active modes – active, short idle, or long idle – actually increased by nearly 10% from 2020 to 2024. This appears related to a declining use of power management features. Specifically, in 2020 about 62% of desktops and 51% of portables were reported to transition to sleep, off, or hibernate; whereas, in 2024, these responses fell to 33% and 39%, respectively. Given the uncertainties in self-reported responses and the usage model, the significance of the apparent increase is unclear.

For monitors, despite an increase in average screen size from 21 to 24 inches, the estimated average active-mode power draw of the monitor installed base decreased by about 34% from 2020 to 2024, primarily due to the retirement of older, less-efficient LCD and CRT displays. That said, brightness settings affect monitor power draw, e.g., recent testing of monitors found that changing the baseline brightness (120 cd/m^2) to the maximum increased power draw by 6 to 88 W, with a median of 12 W (n=43, models from 2020 to 2023; Siderius 2024). Put another way, the maximum to baseline luminance ratio was about 2 to 7 (median 2.5), while the power ratio was about 1.2 to 2.9 (median: 1.8[8]). Both ratios varied appreciably among monitors and we lack the real-world luminance distributions to refine estimates further. Hypothetically, if we assumed that all LCD monitors operated at the midpoint between their maximum and baseline (120 cd/m^2) luminance, our estimated monitor UEC and AEC would increase by about 17 kWh and 1.6 TWh, respectively.

Set-top Boxes (STBs). Our analysis of subscription STB energy consumption is primarily based on the annual voluntary agreement reports (D+R 2014 to 2025). They consumed an estimated 9 TWh in 2024, about 43% less than in 2020. This reflects a 36% reduction in the installed base due to a similar (33%) reduction in the number of cable, telco, and satellite subscribers. Although the UEC of non-DVR STBs decreased by almost 30% from 2020 to 2024, the UEC for the other subscription STB categories did not change appreciably. The average subscription STB power draw in sleep mode continues to be around 15% lower than in on mode.

Small Network Equipment (SNE). Network equipment consumed almost 19 TWh in 2024, with integrated access devices (IADs) accounting for about 78% of the total. The biggest factor in the 27% increase in AEC from 2020 for SNE comes from the increased total number of units installed, with local network equipment units increasing by around 60% since 2020. This likely reflects increased uptake of Wi-Fi extenders and an updated method for estimating the local network equipment installed base. For device categories studied in both 2020 to 2024, the power draw characteristics of installed units have not changed significantly.

A new category of SNE products not covered by the SNE voluntary agreement entered the market in 2020, fixed wireless access (FWA) systems. These devices provide high-speed data services using radio signals, typically from a cellular tower (most common) or via satellite, and supporting on-premise functions typical of IADs. We estimate they served around 12 million households in 2024. Given their appreciable growth, large uncertainties in real-world power draw, and the potentially much higher power draw of satellite-based units,[9] the energy impact of

[8] Note: This median value was incorrectly reported as 1.2 in the text of Urban and Roth (2026).

[9] The specification for Starlink's "mini" and "standard actuated" offerings indicate idle power draw of 15 and 20 W, respectively, with an average active power draw of 20 to 40 W and 50 to 75 W (Starlink 2025). Our preliminary estimate is that satellite FWA systems draw an average of about 32 W.

FWA devices could grow appreciably in the future, albeit likely while cannibalizing the stock of other SNE gateway devices.

Video Game Consoles (VGCs). Video game consoles consumed an estimated 12 TWh in 2024, about 10% more than in 2020 (Urban, Roth, and Olano 2021). This largely reflects an estimated 22% UEC increase driven by higher power draw among newer generation consoles, offset somewhat by lower standby power. The VGC UEC estimates are sensitive to active mode power levels, which vary with title and gameplay. If the current generation Xbox and PlayStation consoles drew 20% less power in active gaming modes than the as-tested values, total VGC AEC would decrease by about 1.3 TWh.

Topics Warranting Further Study

As with all end use characterization studies, the current analyses have varying degrees of uncertainty, with usage and power draw by mode having the greatest uncertainty for most products. Our analyses identified potential future studies that could appreciably decrease the uncertainty in consumer electronics energy consumption estimates; we discuss them in the approximate order of the magnitude of uncertainty each would address.

Television Active-Mode Power Draw: Television active-mode energy consumption accounts for almost one-third of total residential CE energy consumption. Picture settings, like playback resolution and dynamic range, can influence TV active-mode power draw. However, we did not ask about these settings in the CE Usage Survey because we expected respondents could not reliably report these factors for their TVs. On September 11, 2023, a new DOE TV test procedure took effect that aims to measure power draw across a more representative range of picture modes, brightness conditions, and settings (DOE 2023). Since test results performed with the new test procedure are not available for most TVs in the installed base, we did not use it to characterize TV energy consumption. However, as TVs tested to the DOE test procedure comprise a larger portion of the installed base, such data could inform future characterizations of TV energy consumption. Combining those test results with TV display settings and active mode power data – perhaps based on manufacturer telemetry for a representative sample – could improve active-mode power draw estimates and resolve what is likely the largest uncertainty in total residential CE energy consumption.

Computer Usage Hours by Mode: The current study develops bottom-up estimates for computer usage by mode using models that convert responses from a demographically representative sample of around 2,000 U.S. households into device-specific estimates for usage by mode. As discussed earlier, we attempted to frame questions to minimize the impact of social desirability bias, and we and the company fielding the survey used several techniques to identify and remove spurious responses from our sample. However, questions persist about the accuracy of households' responses, particularly to questions used to assess the power management status of computers and monitors. Thus, as with televisions, obtaining actual usage by mode or power time series for a representative sample of computers used in homes could help improve computer usage by mode and UEC estimates.

Computer Power Draw & Real-world Adjustment Factors: This study found large reductions in desktop and portable computer UEC driven by large decreases in tested power draw in short and long idle modes. As noted in the Computers and Monitors section above, the real-word adjustment factors we applied to estimate real-world active, short idle, and long idle power draw values were based on testing from nearly a decade ago, and it is unclear how appropriate they are for the current stock. In particular, the tested power draw of computers in idle modes has decreased appreciably over the past several years, presumably due to much greater use of power-scaling. Since power scaling increases the potential variability in power levels across different modes, there is a renewed need to measure current real-world adjustment factors.

Television Standby Power Draw: When enabled, active standby modes that enable TVs to stay connected, start up more quickly, or wake on a signal from another device can have much higher standby power draw than passive standby modes in some smart TVs. However, the portion of TVs in the installed based with active standby modes enabled is not clear. As with TV active power draw, field studies or manufacturer telemetry for a representative sample of TVs would improve estimates for average standby power draw. A recent Voluntary Agreement seeks to improve the energy efficiency of televisions and limit active standby power to no more than 2 W for at least 90% of units sold starting in 2026 (CTA 2023). Assuming manufacturers meet the performance targets of the VA, that would limit the future impact of active standby modes.[10]

Onboard Artificial Intelligence Power Impacts: Many devices are beginning to support artificial intelligence (AI) capabilities, where some or all of the AI workloads are performed locally onboard the device. It is not yet clear if these features will have a meaningful impact on device level power draw or energy consumption, but this is an area that is changing quickly and worth evaluating if adoption continues to grow.

Indirect CE Energy Impacts: The current study evaluated only the direct energy consumption impacts of consumer electronics in homes. Indirect energy includes embodied energy – the energy used to manufacture the devices – and external energy – the energy used offsite, as in data centers that process, store, and transmit data that consumer electronics generate or use. Direct and indirect energy impacts may be of similar magnitude (e.g., Shehabi et al. 2024, Apple 2025). The integration and use of artificial intelligence features, for example, deserves attention.

Conclusions

We quantified the electricity consumption of consumer electronics in U.S. households in 2024. As in the prior five studies of CE energy consumption completed by the authors, we took a bottom-up approach to estimate the energy consumption of individual device categories based on their installed base, typical annual usage by mode, and power draw by mode. Two web-based household surveys were fielded to identify the installed base and usage patterns of televisions, computers and their monitors, video game consoles, and other devices. The survey responses served as inputs into more detailed energy use models for specific devices.

We estimate that over 3 billion consumer electronics devices consumed about 153 TWh in 2024, equal to about 9.9% of U.S. residential sector and 3.5% of total electricity consumption. Collectively, the devices studied in more depth accounted for about 80% of the total CE AEC, with televisions, the highest consuming category, representing 36% of the total. That is similar to

[10] An initial report for the period covering April 2023 to March 2024 – well before the Agreement takes effect – found that around 70% of the units sold achieved that level of performance (D&R 2024).

combined AEC of the next five devices as ranked by AEC, i.e., desktop computers and their monitors (14%), network gateways (10%), video game consoles (8%), and subscription set-top boxes (6%).

Relative to 2020, total CE energy consumption decreased by 23 TWh decrease, or about 13%. The decrease mainly reflects large decreases in the AEC of four devices: desktop computers (10 TWh, -38%); monitors (6 TWh, -52%); subscription set-top boxes (7 TWh, 43%); and notebook computers (4 TWh, -43%). Large decreases in the modeled active-mode power draw led to AEC decreases for desktop and notebook computers and their monitors, while a 36% decrease in the subscription set-top box installed base accounted for most of the decrease in that category. Of devices studied in the greatest detail, only small network equipment had an appreciable increase in AEC (3 TWh, +21%). Television AEC remained essentially constant, with a higher unit energy consumption due to higher active power draw (from larger reported average screen size) offset by a falling installed base.

Active and idle modes continued to account for the vast majority (85%) of the energy consumed by devices studied in the most depth.

The last residential CE energy consumption study, for 2020 during the height of the COVID-19 pandemic, found active mode usage increases of 30-50% relative to 2017 for several key device categories, i.e., TVs, video game consoles, desktop and portable computers, and monitors, as people spent far more time at home. That higher usage drove much of the estimated 33 TWh increase in total CE energy consumption from 2017 to 2020. The current study indicated that the higher active usage may persist for some devices. For example, in 2024, the reported active hours per TV was only about 4% less than in 2020, while active hours for video game consoles were about 10% higher than in 2020. The overall *energy* impacts are mixed, however, due to changes in other factors like power draw, idle mode usage, and installed base within categories. Notably, despite the sharp decline in user-reported computer active usage in 2024, the estimated total time spent in *any* active mode – active, short idle, or long idle – actually increased by nearly 10% from 2020 to 2024.

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