Consumer Electronics in U.S. Homes
Energy Use in 2017

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Fourth Study in a Series

2006  2010  2013  2017

GOAL
Quantify the energy use of Consumer Electronics installed in U.S. Homes

WHY CONSUMER ELECTRONICS?
U.S. Electricity Use (2016)

3,700 TOTAL TWh*
1,400 Residential
148 Consumer Electronics

11% of Residential

*1 TWh = 1 Billion kWh
Consumer Electronics

- 3.5 billion devices
- 119 million homes
- 148,000,000,000 kWh/yr
- $16 billion energy cost
Per Household

- 30 devices
- 44 kWh/device
- 1,300 kWh/yr
- $150 per year
METHOD
Bottom-up Calculations

\[
\text{POWER DRAW (W)} \times \text{ANNUAL USAGE (hours)} = \text{UNIT ELECTRICITY CONSUMPTION (kWh/yr)}
\]

\[
\begin{align*}
\text{MODE} & \quad \text{P}_\text{active} \times T_\text{active} = UEC_{\text{active}} \\
\text{ACTIVE} & \\
\text{SLEEP} & \quad \text{P}_\text{sleep} \times T_\text{sleep} = UEC_{\text{sleep}} \\
\text{OFF} & \quad \text{P}_\text{off} \times T_\text{off} = UEC_{\text{off}} \\
\sum & = UEC \times \text{INSTALLED BASE (millions)} = \text{AEC}
\end{align*}
\]

\[
\text{TOTAL DEVICE UEC (kWh/yr)} = UEC \times \text{INSTALLED BASE (millions)} = \text{AEC}
\]

\[
\text{ANNUAL ENERGY CONSUMPTION (TWh)} = \text{AEC}
\]
Consumer Electronics Usage Surveys

1,000 households*
How many devices were plugged last month?
How were they used?

*500 landline/500 cell phone
Voluntary Energy Efficiency Agreements

Set-Top Box
Small Network Equipment

Industry stakeholder commitment to energy efficiency goals for newly shipped products.

Third-party auditing: measurement, testing, reporting.

Reports indicate sales-weighted power draw of new equipment.

>90% of purchased products met these standards

See: http://www.energy-efficiency.us
Device Categories Studied in Depth

- Televisions
- Set-Top Boxes
- Sound Bars
- Video Game Consoles
- Computers
- Monitors
- Network Equipment

80/30 RULE

These 1.1 billion devices account for about 80% of the total energy consumption.
Device Categories Studied in Depth

Televisions
Set-Top Boxes
Sound Bars
Video Game Consoles

Computers
Monitors
Network Equipment

These 0.7 billion devices account for about 60% of the total energy consumption.
Other Devices (Less Depth)

**AUDIO**
- AV Receiver w/ Surround
- Computer Speakers
- Home Theater In-a-Box
- Radio + Clock Radio
- Shelf Stereo + Compact Audio
- Speaker Dock

**DISC PLAYER**
- Blu-ray Player
- CD player, standalone
- DVD Player

**SET-TOP BOX (Standalone)**
- DVR
- Over-the-air DTA
- Digital Media Streaming
- VCR

**VIDEO**
- Digital Picture Frame
- Video Projector
- Web Camera

**INFO-TECH**
- External Storage Drive
- Printer + Multi-function

**PHONE**
- Cordless Phone
- Internet-based Phone
- Telephone Answering Device

**PORTABLE DEVICES**
- Bluetooth Headset
- Wireless Speaker
- DVD or Blu-ray Player
- Media player, MP3+CD
- eReader
- GPS, handheld
- Smart Watch + Wearable
- Tablet Computer
- Mobile Non-Smart Phone
- Mobile Smart Phone
- Camcorder
- Digital Camera
- Video Game Console

These **2.4 billion** devices account for about **20%** of the total energy consumption.
MACRO TRENDS

2006 2010 2013 2017

2.1 3.5

2006 2010 2013 2017

78 43

2006 2010 2013 2017

193 148

20% decline since 2010

billion units \times kWh per device /yr = TWh
HIGHLIGHTS
TV Trends

<table>
<thead>
<tr>
<th>UNITS (millions)</th>
<th>191</th>
<th>284</th>
<th>353</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak TVs in 2010</td>
<td>(more TVs than people)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UEC (kWh/yr)</th>
<th>141</th>
<th>244</th>
<th>118</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak UEC in 2006</td>
<td>(many CRTs)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AEC (TWh)</th>
<th>26</th>
<th>67</th>
<th>34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steep drop in AEC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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CRTs give way for LCDs...

About 21 million CRTs left
308 million TVs owned

284 million TVs plugged in
Where Are They Now?
TERRARIUM
Usage is Still High...

3.9 hours/day per TV

5 hours/day per person

Usage may have decreased slightly, competition from other screens.
TV Power Draw Trends

Mechanical Scanning TV (1920s)
ROTATING DISK

NEON LAMP

MOTOR

VIEWING LENS (1.5 in²)

POWER DENSITY:
5 W (?) = 3,000 mW/in²
>10x higher than LCD
Brightness Settings and Viewing Modes

Default Mode: Retail Mode = 0.85 on average.

Further study needed to determine what settings people actually use.

Automatic Brightness Control

POWER DENSITY (mW/in.²)

ABC disabled

ABC enabled

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Passive Standby

<1 W for most TVs
Smart TVs and Connected Standby

About HALF of homes have at least one Smart TV.

About 27% of homes had at least one Smart TV enabled.

Passive Standby: Fleet average of about 1 W

Active Standby could be about 10 W for Smart TVs with this feature enabled.
Soundbars

Newer category with rapid growth

20 million units
65 kWh/ year
1 TWh

5.1 Channel Soundbar

POWER (W)

MANUALLY OFF (still connected)

CONNECTION STANDBY

MANUALLY ON (not playing)

PLAYING

MAX. vol

LOUD

VOL. RAMP

NORMAL

CONNECTED STANDBY

IDLE

IDLE

ACTIVE

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SET-TOP BOXES (SUBSCRIPTION)
Set-top Box Trends

UNITS (millions)

Shift Towards Thin Client

UEC (kWh/yr)

AEC (TWh)

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Set-top Box Power Draw

High Variability Among Devices

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How To Build The S & I TELEVISION RECEIVER
Computer Trends

Shift Towards Portables

UEC and AEC Sensitive to Usage Model
Computer Power Draw

Computers Actively Used for 4-5 hours/day

- Desktops: 4.8 h/day
- Portables: 3.9
- ALL: 4.3
Manual Power Management Rates Reasonably High

DAYTIME
1/3 report shutting down
1/3 report sleep or standby

NIGHT
About half shut down
(Fig. below)

### Manual Power Management

<table>
<thead>
<tr>
<th></th>
<th>NEVER</th>
<th>OCCASIONALLY</th>
<th>HALF-THE-TIME</th>
<th>OFTEN</th>
<th>ALWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop 1</td>
<td>28%</td>
<td>15%</td>
<td>7%</td>
<td>46%</td>
<td></td>
</tr>
<tr>
<td>Desktop 2</td>
<td>24%</td>
<td>9%</td>
<td>8%</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td>Portable 1</td>
<td>18%</td>
<td>15%</td>
<td>7%</td>
<td>58%</td>
<td></td>
</tr>
<tr>
<td>Portable 2</td>
<td>16%</td>
<td>16%</td>
<td>10%</td>
<td>55%</td>
<td></td>
</tr>
</tbody>
</table>
Automatic Power Management Rates

Based on people who always leave their computer on overnight.
Gaming PCs

Wildcard subcategory.

Enthusiast gaming computers can use much more energy.

Gaming power draw can add 100+ W to active mode.

Primarily due to dedicated graphics processing units (GPUs).
Video Game Console Power Draw

Varies by console.

Changes with new hardware releases.
Video Game Consoles

In Active Modes for 0.5 to 4 hours Per Day

Crossover video usage...
DVD and Blu-ray
Video Streaming

<table>
<thead>
<tr>
<th>Console</th>
<th>Gaming</th>
<th>Streaming</th>
<th>Video Playback</th>
<th>Navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xbox One S</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xbox One</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xbox 360</td>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xbox</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PlayStation 4</td>
<td>3.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PlayStation 3</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PlayStation 2</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wii U</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wii</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(h/day)
CONCLUSIONS
Unit Energy Consumption

Most consumption in active modes, with some exceptions.

45-200 kWh/yr per device

- Desktop Computer
- Integrated Modem
- Computer Monitor
- Router
- Broadband Modem
- Portable Computer
- Non-DVR: STB
- Television
- DVR: STB
- Video Game
- Sound Bar
- Thin Client: STB
- DTA Adapter: STB

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Results

UNITs (millions)
- Television
- Non-DVR STB
- DVR STB
- Thin Client STB
- DTA Adapter STB
- Soundbar
- Video Game
- Desktop Computer
- Portable Computer
- Computer Monitor
- Integrated Modem
- Router
- Broadband Modem

UEC (kWh/yr)

AEC (TWh)
- 34
- 18
- 10
- 8
- 7
- 9
- 3
- 1

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Key Takeaways for 2017

3.5 billion devices used 148 TWh
(20% less than in 2010)

Driven largely by new, more-efficient
devices displacing older devices.
Especially TVs.

TVs and Set-top Boxes now use similar
amounts of energy (~35 TWh).
Stay Tuned for the Final Report
Contact

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