United States Data Center Energy Usage Report

BY

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Introduction

- In 2014, data centers in the U.S. consumed an estimated 70 billion kWh, representing 1.8% of total U.S. electricity consumption.

- Current study results show data center electricity consumption increased by about 4% from 2010-2014, a large shift from the 24% percent increase estimated from 2005-2010 and the nearly 90% increase estimated from 2000-2005.

- Based on current trend estimates, U.S. datacenters are projected to consume approximately 73 billion kWh in 2020.

- Many factors have resulted in the above happening, most important being the reduced growth in the number of servers in datacenters.

- Current server growth rate is at 3%, which can be attributed to rise in very large “hyperscale” datacenters and moving localized datacenter activity to colocation or cloud facilities.
Along with total server count, the power demand for each server has also changed.

While server power requirements were observed to be increasing from 2000-2005, power demand appears to have stayed fairly constant since 2005.

Additionally, servers are improving in their power scaling abilities, thus reducing power draw during idle periods or when at low utilization.

Efficiency improvements in storage, network and infrastructure also influence the electricity estimates in this report.

Storage devices are becoming more efficient on a per-drive basis, with the growth in drive storage capacity projected to outpace increases in data storage demand by 2020, ultimately reducing the number of physical drives needed throughout data centers.

Increased awareness in data center infrastructure operations (e.g. cooling) has resulted in improved efficiency across data center types.
Projected Data Center Total Electricity Shift

![Graph showing projected data center total electricity shift from 2000 to 2020. The graph illustrates the expected annual electricity use (in billion kWh/year) under different scenarios such as 2010 Energy Efficiency, Current Trends, Improved Management, Hyperscale Shift, IM + HS, Best Practices, and BP + HS. The graph indicates a significant shift in energy usage as we move towards 2020.]
Additional projections

• **IM: “Improved management”** scenario includes energy-efficiency improvements beyond current trends that are either operational or technological changes that require minimal capital investment. This scenario represents a focus on improving the least efficient components of the data center stock by employing practices already commonly used in data centers.

• **BP: “Best practices”** scenario represents efficiency gains obtained through widespread adoption of efficient technologies and best management practices for each data center type. This scenario focuses on maximizing the efficiency of each type of data center facility.

• **HS: “Hyperscale shift”** scenario represents an aggressive shift of data center activity from smaller data centers to larger data centers. While the current trend scenario already incorporates some movement towards more server use in large data centers, this scenario assumes the majority of servers in the remaining small data centers are also relocated.
Equipment Types Modeled in Energy Estimation

Data Center IT Equipment

Servers
- Branded 1-Socket
- Unbranded 1-Socket
- Branded 2-Socket+
- Unbranded 2-Socket+
- Mid-range
- High-End

External Storage
- Hard Disk Drive
- Solid State Drive

Networking
- 100 MB Ports
- 1000 MB Ports
- 10 GB Ports
- 40 GB Ports
Schematic of Modelling Approach
Server Installed Base

Figure 4. Unbranded Server Installed Base and Underlying Assumptions
Continued..
Server Energy Use

Figure 7. Average Power Draw Assumptions for Mid-Range and High-End Servers

Table 1. Average Active Volume Server Utilization Assumptions

<table>
<thead>
<tr>
<th>Space Type</th>
<th>2000-2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Service Provider</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Hyperscale</td>
<td>45%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Assumed Dynamic Range (DR) of servers
Figure 11. Total U.S. Annual Direct Server Electricity Consumption by Server Class
Storage Energy Use

Figure 12. Total U.S. Data Center Storage Installed Base in Capacity (TB)
Network Energy Use

Figure 17. Total U.S. Data Center Installed Base of Network Ports
Continued..
## Characteristics of Space Type

### Table 2. Typical IT Equipment and Site Infrastructure System Characteristics by Space Type

<table>
<thead>
<tr>
<th>Space type</th>
<th>Typical size</th>
<th>Typical infrastructure system characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal server closet</td>
<td>&lt; 100 ft²</td>
<td>Often outside of central IT control (often at a remote location) that has little to no dedicated cooling.</td>
</tr>
<tr>
<td>Internal server room</td>
<td>100-999 ft²</td>
<td>Usually under IT control, may have some dedicated power and cooling capabilities.</td>
</tr>
<tr>
<td>Localized internal datacenter</td>
<td>500-1,999 ft²</td>
<td>Has some power and cooling redundancy to ensure constant temperature and humidity settings.</td>
</tr>
<tr>
<td>Midtier internal datacenter</td>
<td>2,000-19,999 ft²</td>
<td>Superior cooling systems that are probably redundant.</td>
</tr>
<tr>
<td>High-end internal datacenter</td>
<td>&gt; 20,000 ft²</td>
<td>Has advanced cooling systems and redundant power.</td>
</tr>
<tr>
<td>Point-of-presence server closet</td>
<td>&lt; 100 ft²</td>
<td>At local points of presence for OSS and BSS services. Typically leverages POP power and cooling. Space is often a premium.</td>
</tr>
<tr>
<td>Point-of-presence server room</td>
<td>100-999 ft²</td>
<td>Secondary computer point of presence for OSS and BSS services. Typically leverages POP power and cooling.</td>
</tr>
<tr>
<td>Localized service provider datacenter</td>
<td>500-1,999 ft²</td>
<td>Has some power or cooling redundancy to ensure constant temperature and humidity settings. These are typically facilities set up by VARs to provide managed services for clients.</td>
</tr>
<tr>
<td>Midtier service provider datacenter</td>
<td>2,000-19,999 ft²</td>
<td>Location for small or midsize collocation/hosting provider. Also includes regional facilities for multinational communications service providers. Has superior cooling systems that are probably redundant.</td>
</tr>
<tr>
<td>High-end service provider datacenter</td>
<td>&gt; 20,000 ft²</td>
<td>Primary server location for a service provider. May be subdivided into modules for greater flexibility in expansion/refresh. Has advanced cooling systems and redundant power.</td>
</tr>
<tr>
<td>Hyperscale datacenter</td>
<td>Up to over 400,000 ft²</td>
<td>Primary server location for large collocation and cloud service providers. Based on modular designs, with individual modules of 50,000 sq ft on average in up to 8 modules. Employs advanced cooling systems and redundant power.</td>
</tr>
</tbody>
</table>

### Table 3. Allocation of Data Center Equipment Across Space Types

<table>
<thead>
<tr>
<th>Step</th>
<th>Equipment</th>
<th>Allocation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total Servers</td>
<td>• Set percentage (varies annually) to Hyperscale&lt;br&gt; • Remaining based on estimated data center counts and 2005 servers per data center estimate</td>
</tr>
<tr>
<td>2</td>
<td>Midrange Servers</td>
<td>• 5% Server Rooms&lt;br&gt; 30% Localized and Mid-tier Data Centers&lt;br&gt; 65% Enterprise Data Centers</td>
</tr>
<tr>
<td>3</td>
<td>High-End Servers</td>
<td>• 30% Localized and Mid-tier Data Centers&lt;br&gt; 70% Enterprise Data Centers</td>
</tr>
<tr>
<td>4</td>
<td>Unbranded 1S and 2S+ Volume Servers</td>
<td>• 100% Hyperscale Data Centers</td>
</tr>
<tr>
<td>5</td>
<td>Branded 2S+ Volume Servers</td>
<td>• Fill remaining spots in Hyperscale</td>
</tr>
<tr>
<td>6</td>
<td>Branded 1S and 2S+ Volume Servers</td>
<td>• Fill remaining spots in all other data centers, keeping 1S and 2S+ in equal proportion</td>
</tr>
<tr>
<td>7</td>
<td>Storage</td>
<td>• None in Server Closets or Rooms&lt;br&gt; • Allocated to all other spaces based on total server count</td>
</tr>
<tr>
<td>8</td>
<td>Network Ports</td>
<td>• Total allocated based on total server count, with higher speeds trending towards larger data centers</td>
</tr>
</tbody>
</table>
Total Electricity Consumption by Technology Type
Data Center Electricity Consumption in Current Trends and 2010 Energy Efficiency Scenarios

Total Data Center Electricity Consumption (billion kWh)

- Infrastructure Savings
- Network Savings
- Storage Savings
- Server Savings

Current Trends

Savings: 620 billion kWh