United States Data Center Energy Usage Report

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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.

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- 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.

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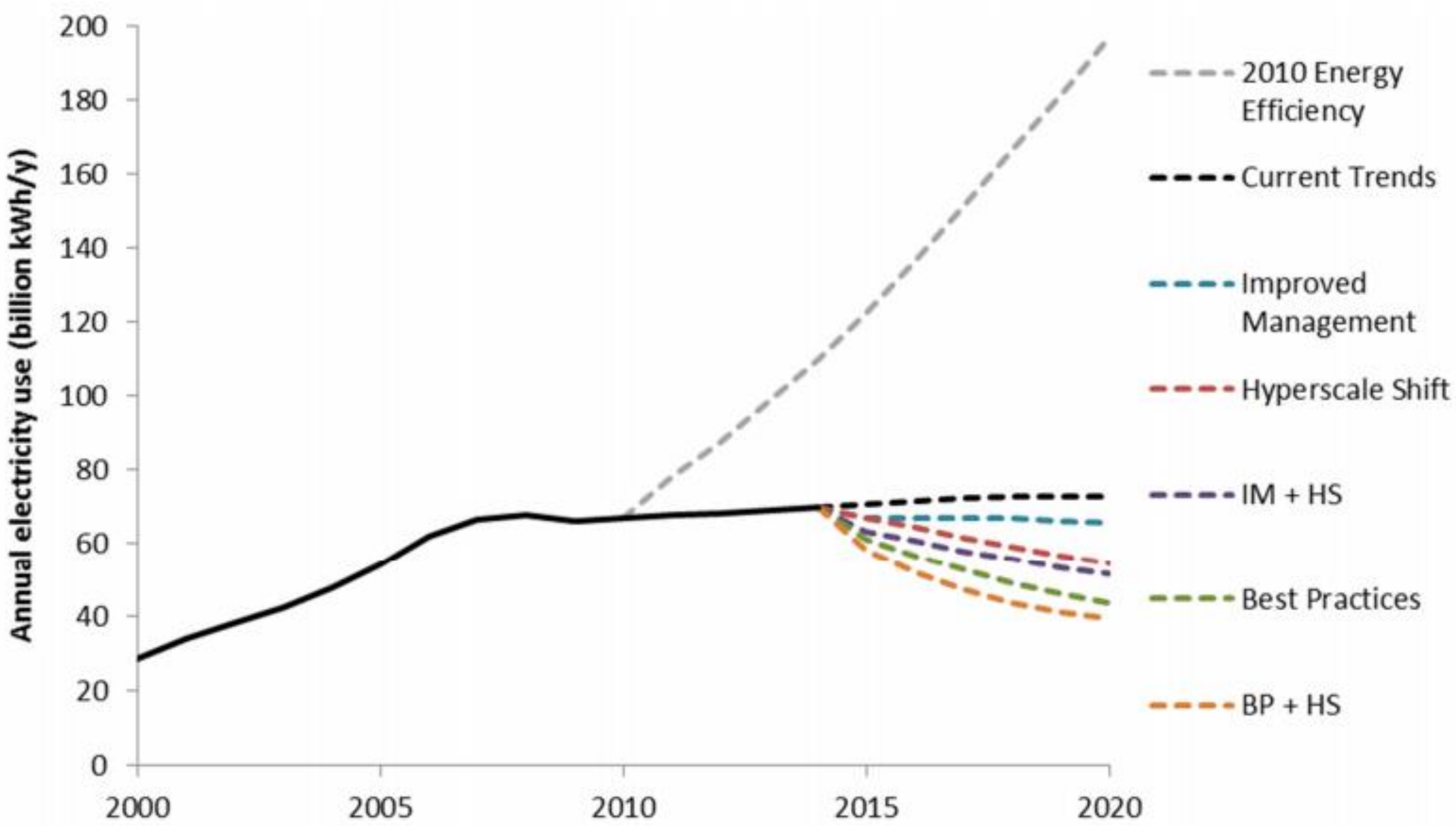
Projected Data Center Total Electricity Shift



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.

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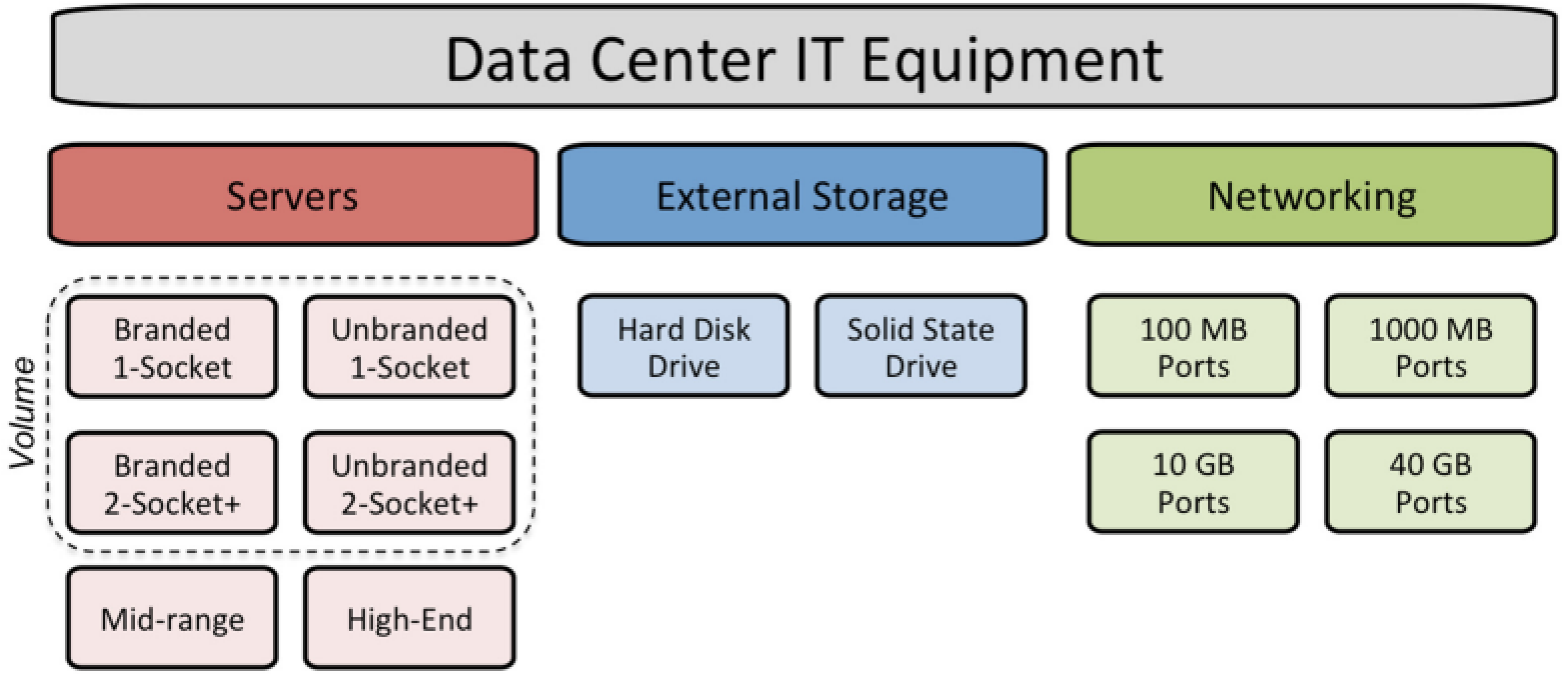
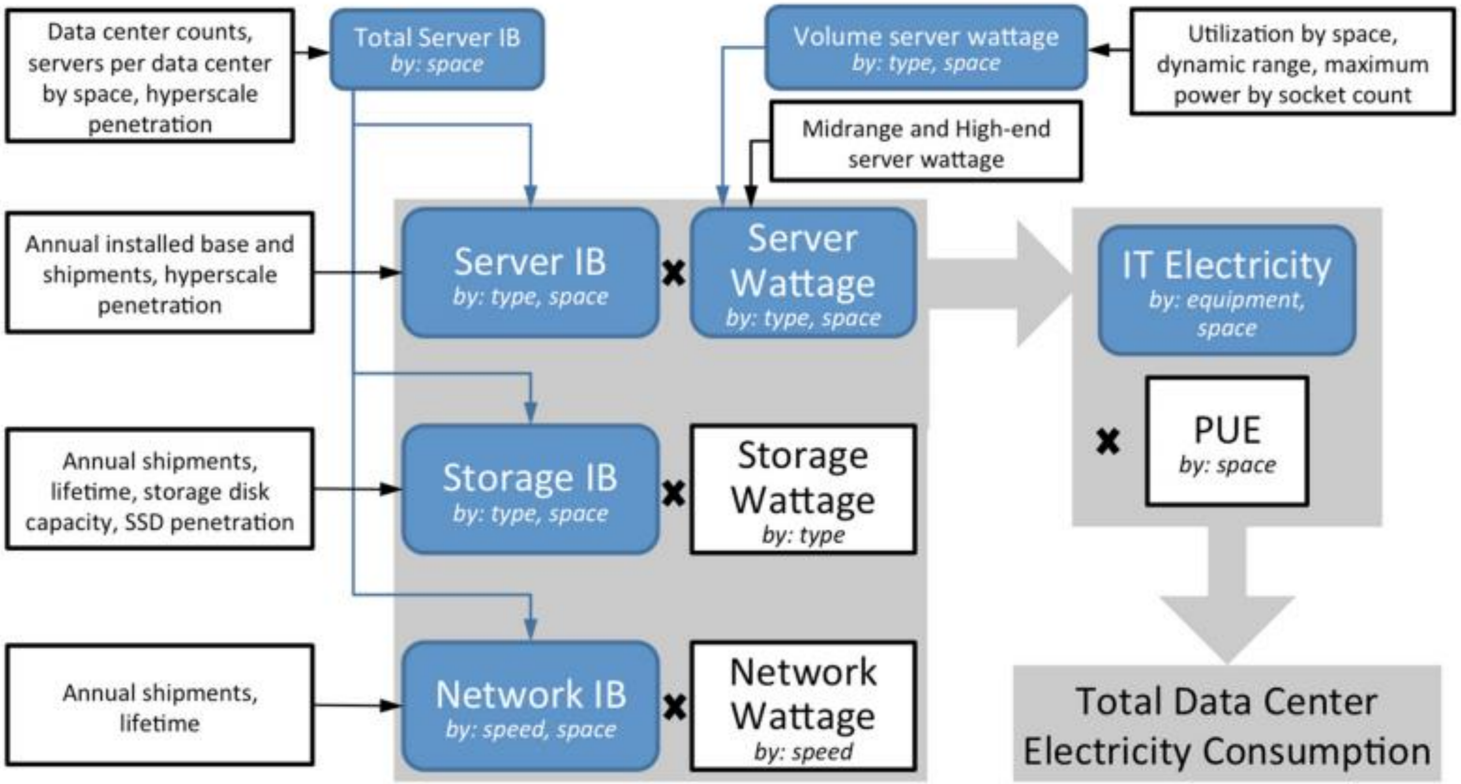
Equipment Types Modeled in Energy Estimation



Schematic of Modelling Approach



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Server Installed Base

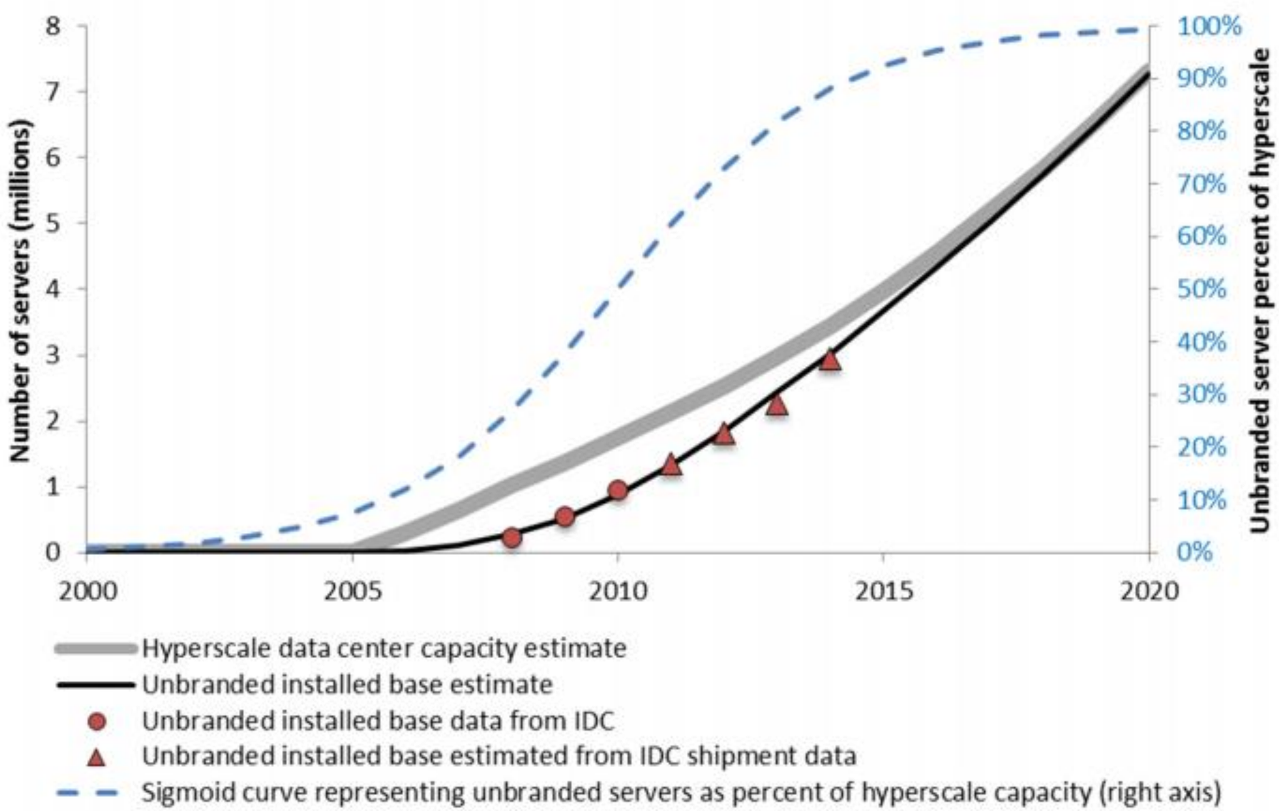

Figure 4. Unbranded Server Installed Base and Underlying Assumptions

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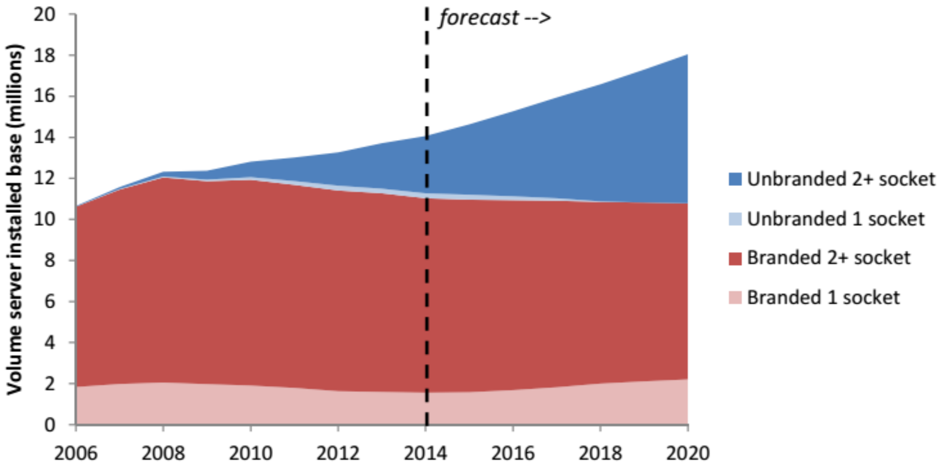

Figure 6. Volume Server Installed Base 2000-2020

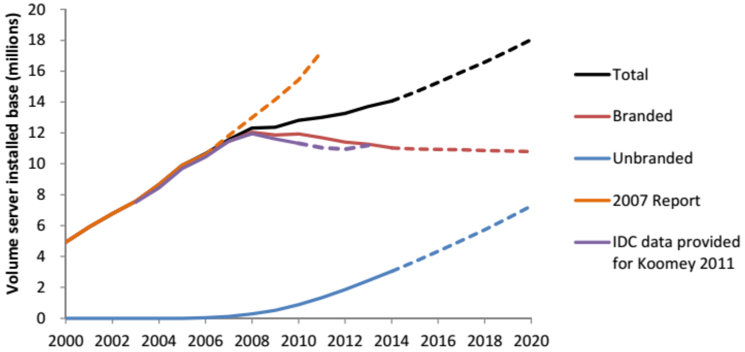

Figure 5. Total Volume Server Installed Base Estimates from Three Studies

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Server Energy Use

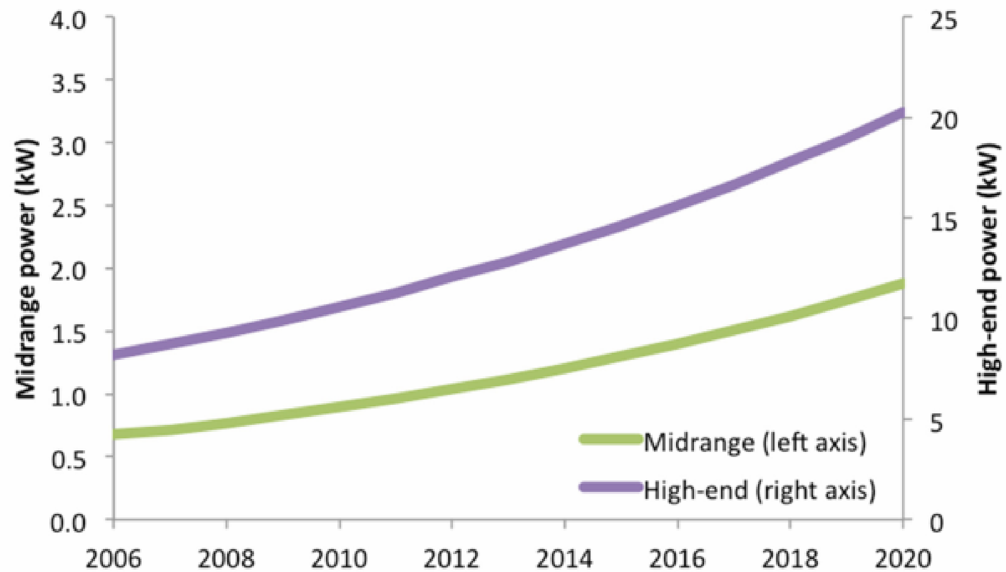

Figure 7. Average Power Draw Assumptions for Mid-Range and High-End Servers

Table 1. Average Active Volume Server Utilization Assumptions

Space Type	2000-2010	2020
Internal	10%	15%
Service Provider	20%	25%
Hyperscale	45%	50%

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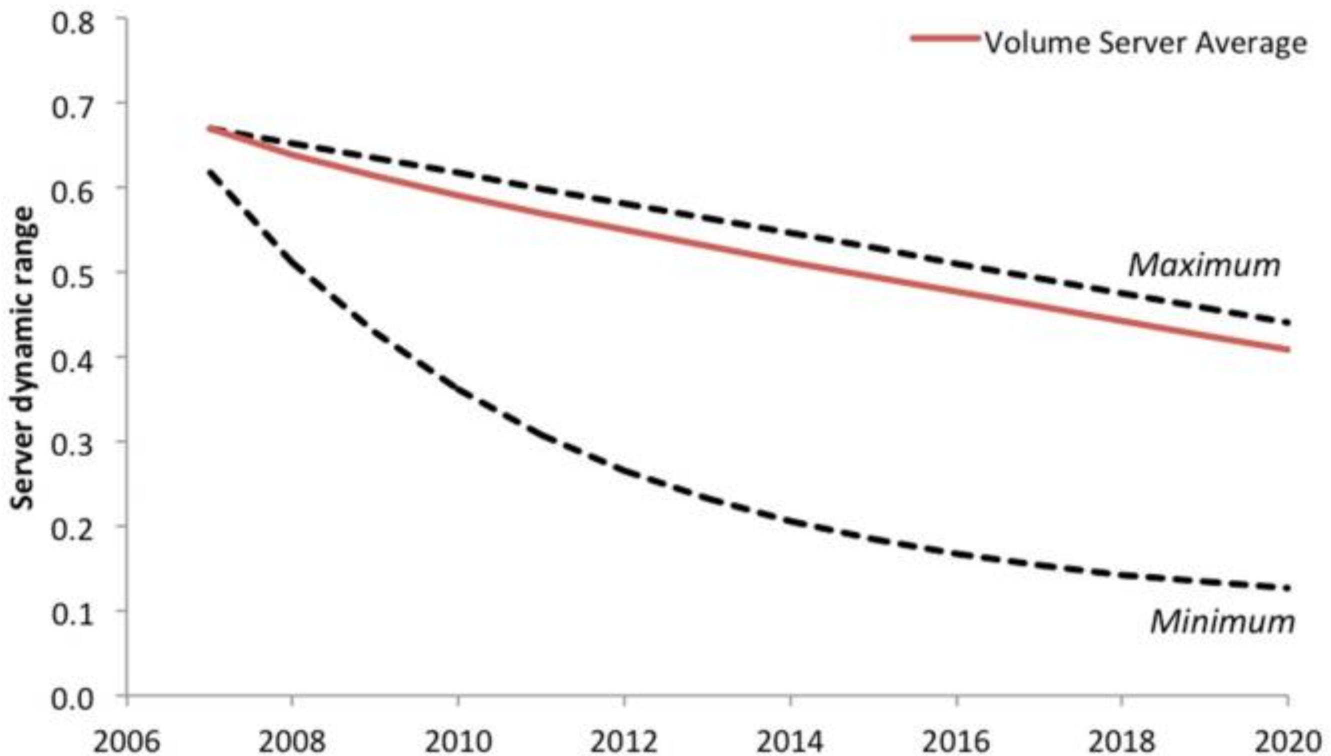

Assumed Dynamic Range (DR) of servers

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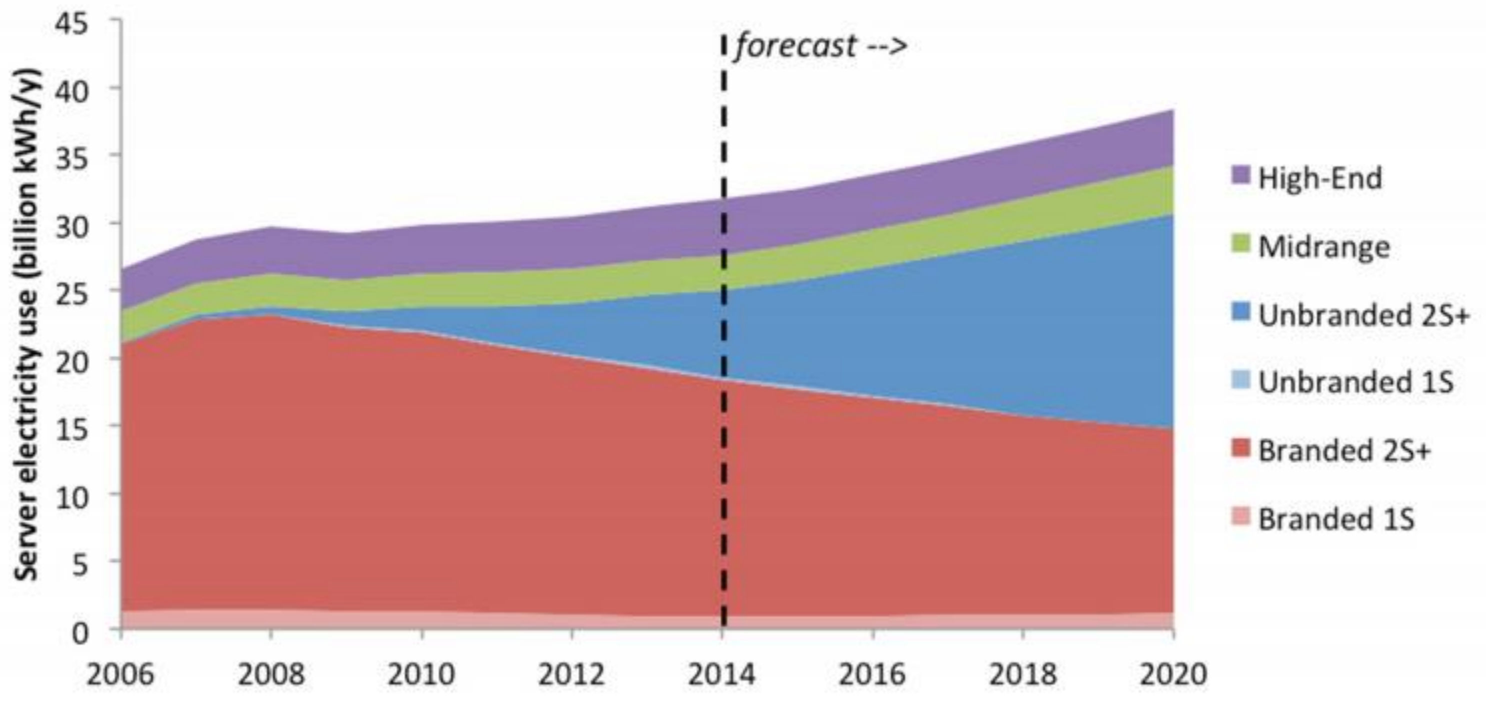

Figure 11. Total U.S. Annual Direct Server Electricity Consumption by Server Class

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Storage Energy Use

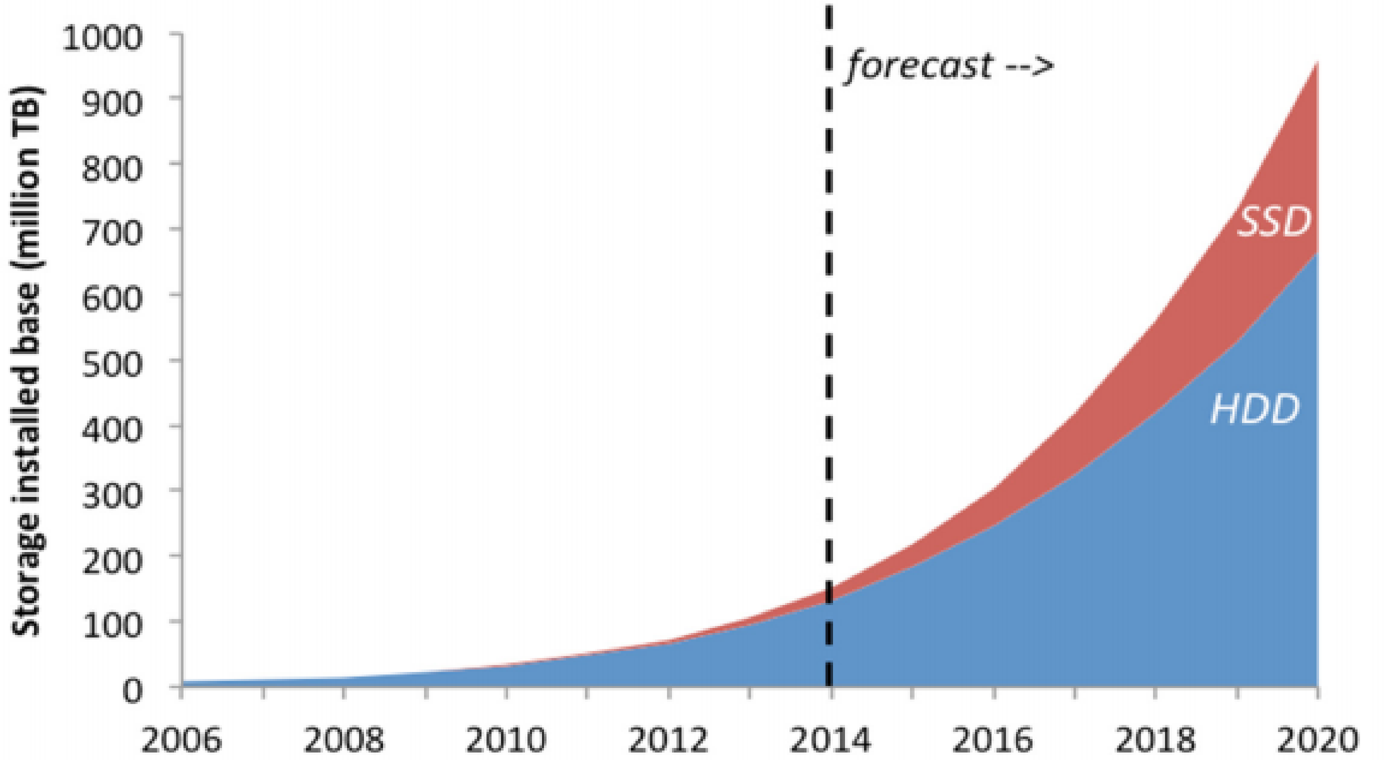

Figure 12. Total U.S. Data Center Storage Installed Base in Capacity (TB)

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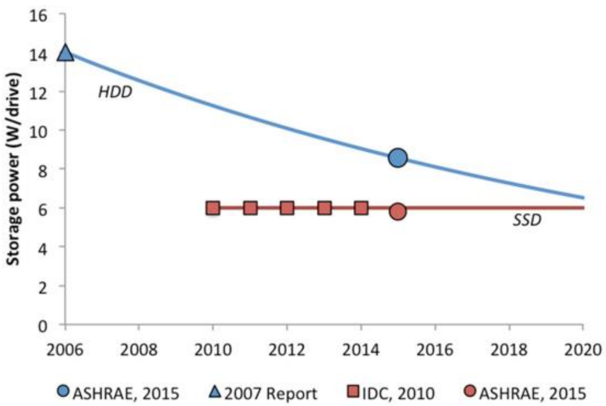

Figure 15. Average Wattage of Storage Drives in U.S. Data Centers

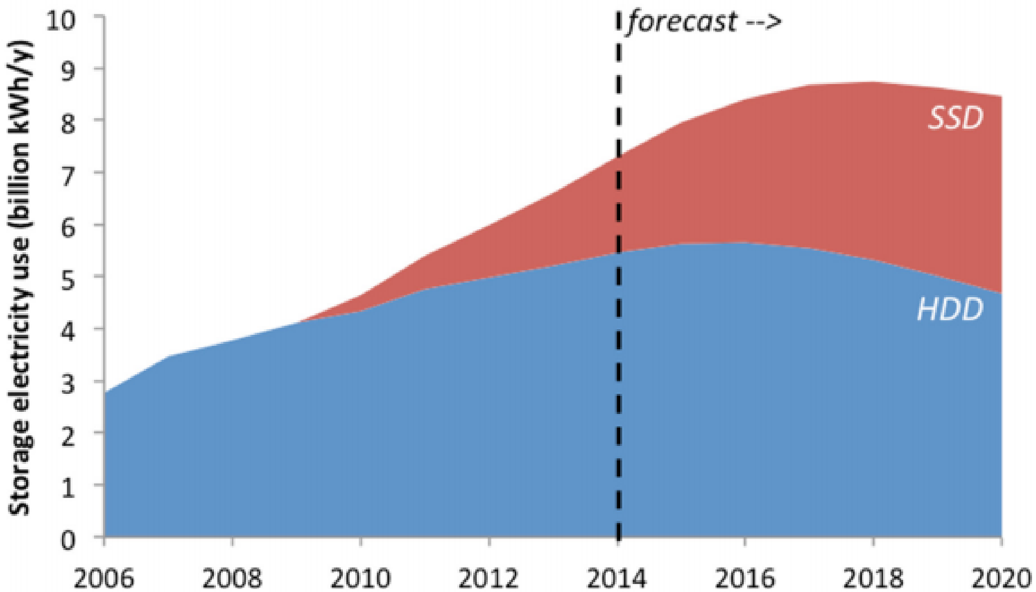

Figure 16. Total U.S. Data Center Storage Electricity Consumption

Network Energy Use

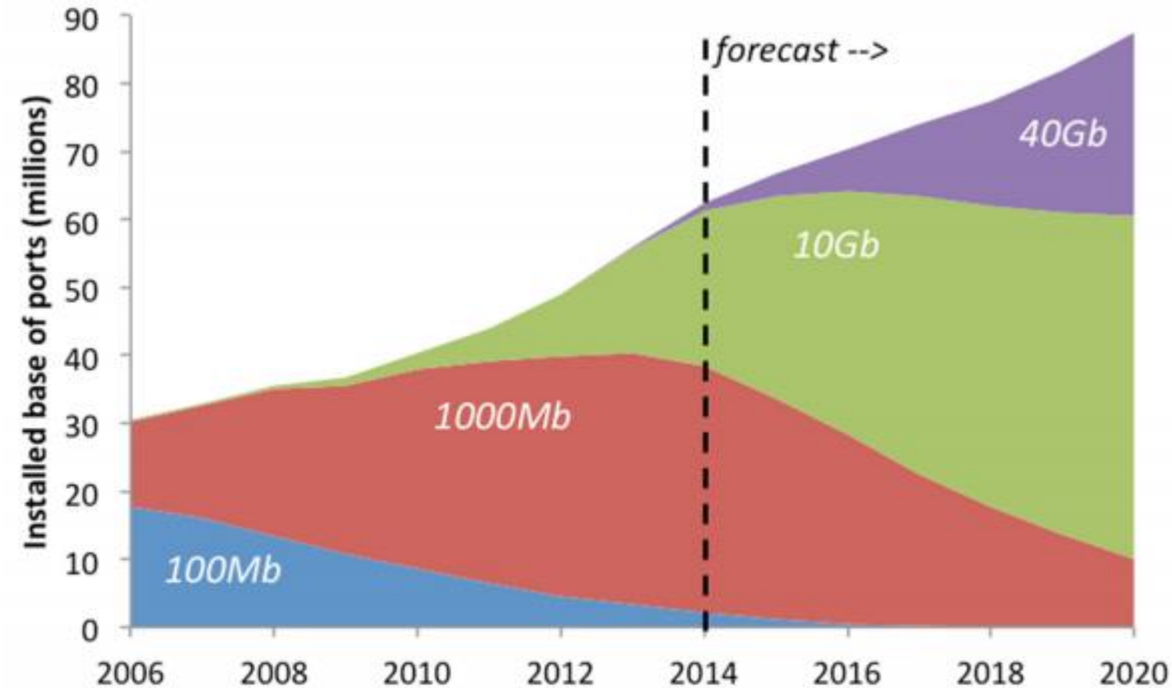

Figure 17. Total U.S. Data Center Installed Base of Network Ports

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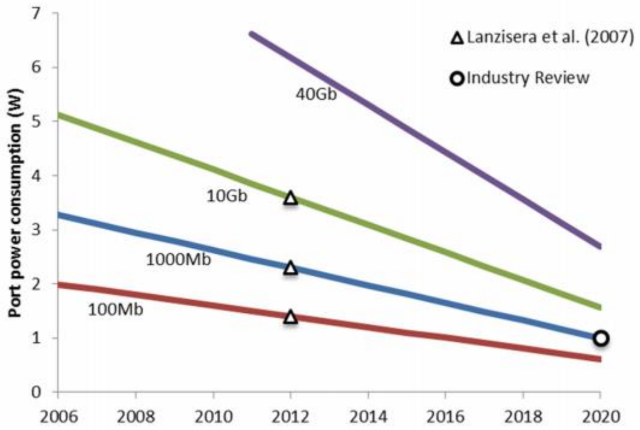

Figure 18. Assumed Network Power for Four Port Speeds

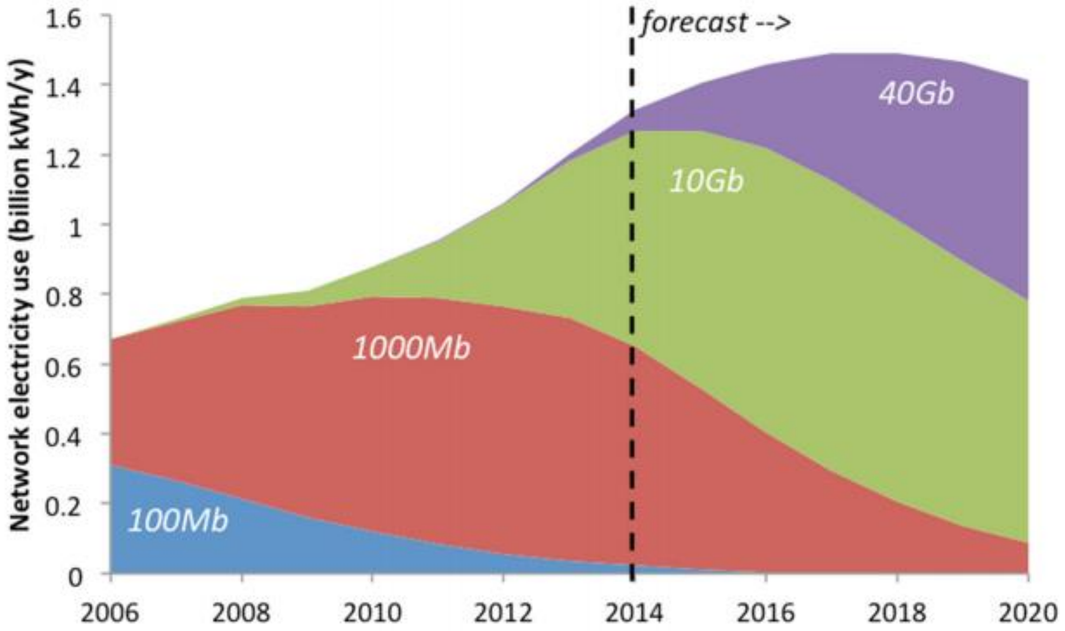

Figure 19. Total U.S. Data Center Network Equipment Electricity Consumption

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Characteristics of Space Type

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

Space type	Typical size	Typical infrastructure system characteristics
Internal server closet	< 100 ft^2	Often outside of central IT control (often at a remote location) that has little to no dedicated cooling.
Internal server room	100-999 ft^2	Usually under IT control, may have some dedicated power and cooling capabilities.
Localized internal datacenter	500-1,999 ft^2	Has some power and cooling redundancy to ensure constant temperature and humidity settings.
Midtier internal datacenter	2,000-19,999 ft^2	Superior cooling systems that are probably redundant.
High-end internal datacenter	> 20,000 ft^2	Has advanced cooling systems and redundant power.
Point-of-presence server closet	< 100 ft^2	At local points of presence for OSS and BSS services. Typically leverages POP power and cooling. Space is often a premium.
Point-of-presence server room	100-999 ft^2	Secondary computer point of presence for OSS and BSS services. Typically leverages POP power and cooling.
Localized service provider datacenter Including subsegment: containerized datacenter	500-1,999 ft^2	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.
Midtier service provider datacenter Including subsegment: prefabricated datacenter	2,000-19,999 ft^2	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.
High-end service provider datacenter	> 20,000 ft^2	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.
Hyperscale datacenter	Up to over 400,000 ft^2	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.

Table 3. Allocation of Data Center Equipment Across Space Types

Step	Equipment	Allocation Method
1	Total Servers	• Set percentage (varies annually) to Hyperscale • Remaining based on estimated data center counts and 2005 servers per data center estimate
2	Midrange Servers	• 5% Server Rooms 30% Localized and Mid-tier Data Centers 65% Enterprise Data Centers
3	High-End Servers	• 30% Localized and Mid-tier Data Centers 70% Enterprise Data Centers
4	Unbranded 1S and 2S+ Volume Servers	• 100% Hyperscale Data Centers
5	Branded 2S+ Volume Servers	• Fill remaining spots in Hyperscale
6	Branded 1S and 2S+ Volume Servers	• Fill remaining spots in all other data centers, keeping 1S and 2S+ in equal proportion
7	Storage	• None in Server Closets or Rooms • Allocated to all other spaces based on total server count
8	Network Ports	• Total allocated based on total server count, with higher speeds trending towards larger data centers

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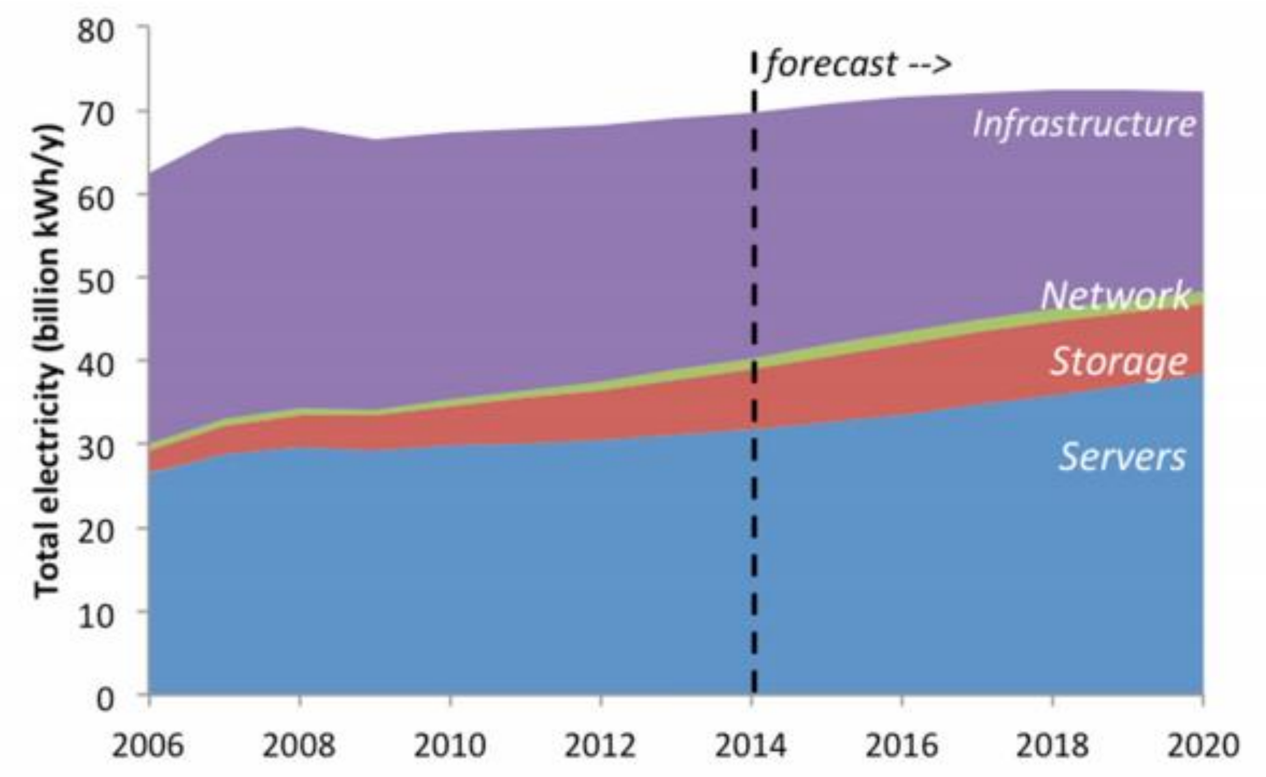
Total Electricity Consumption by Technology Type



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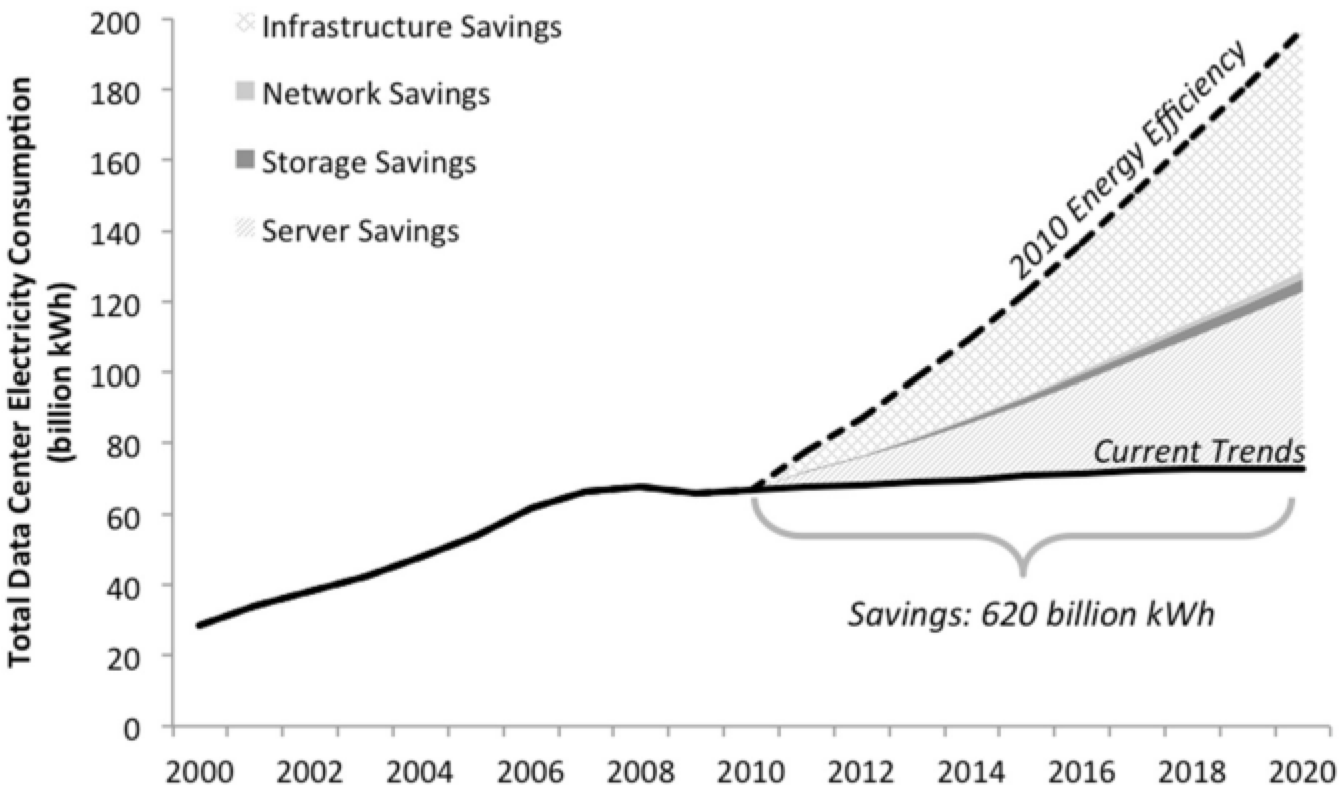
Data Center Electricity Consumption in Current Trends and 2010 Energy Efficiency Scenarios



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