Examining the Embodied Energy Consumption of Cloud Computing Datacenters

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Objectives

- Develop a model to estimate the growth of operational and embodied energy consumption of datacenters.
- Optimize the replacement cycle of components for overall energy consumption.

- Taking advantage of advancements in energy efficiency of next generation would require constant replacement of components associated with storage, netorking and computation.

- Replacement is not only costly but also results in increased energy consumption in fabrications and factories producing those components.

- Only 32.2% e-waste was recycled in the EU in 2014, resulting in a significant sociological and physical impact of extraction of raw materials.

- Reducing the overrall impact of data centers means limiting the production energy whilst maintaining the benefits of next gen technology.

- Specific data for the energy used in the production of components is not made readily available by the IT sector.

- Reasonable estimates can be made using the material breakdown of components, and data from readily available and well maintained databases presenting the embodied energy and recylcing rates of raw materials.

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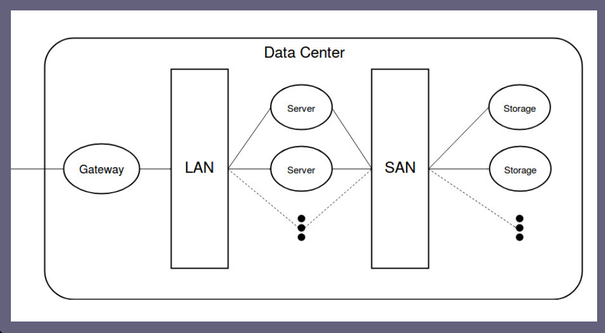
Component	PCB(%)	Semiconductors(%)	Steel(%)	Other(%)	Source
Server	37.23	30.76	24.03	7.98	
Switch	29.71	53.99	13.23	3.07	
SSD	3	93	1	N/A	

Total energy consumption of a data center can be defined as the combined impact of the operational and embodied energy consumption.

$$E_{total} = E_{op} + E_{em}$$



Monte Carlo Simulation

-Performance predictions for next generation equipment are not precise.

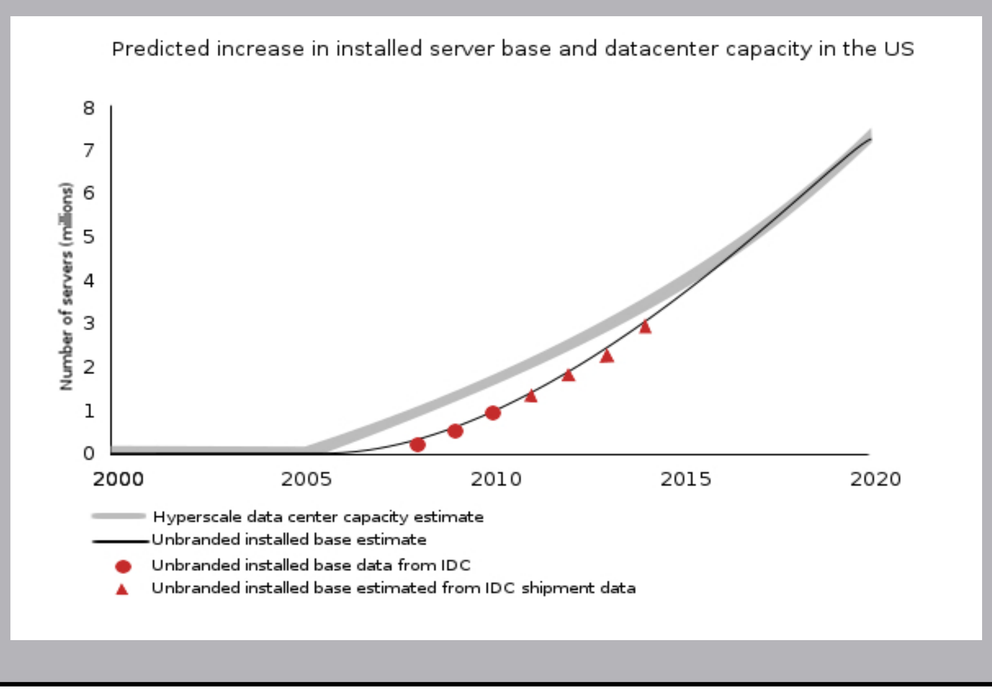
-Uncertainty is accounted for by using Monte Carlo simulation techniques.

- The replacement of components due to normal failure, as well as those which components which are upgraded at the appropriate time in the replacement cycle, are simulated using random sampling.

- Data centers consumed between 1% and 2% of the total worldwide energy consumption in 2011.

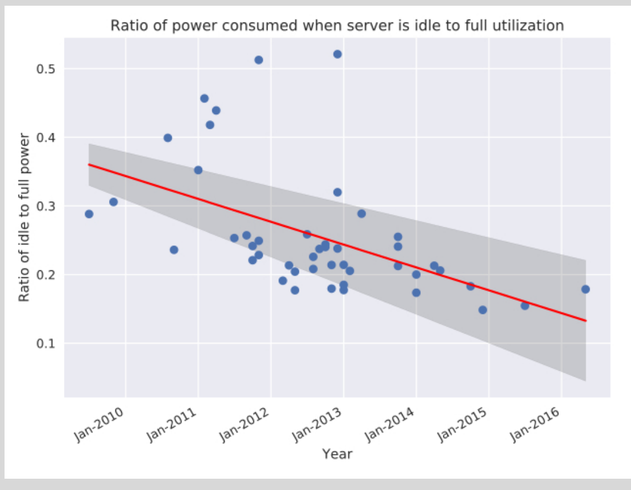
- Energy consumption in data centers contributes a significant cost of running for cloud service providers.

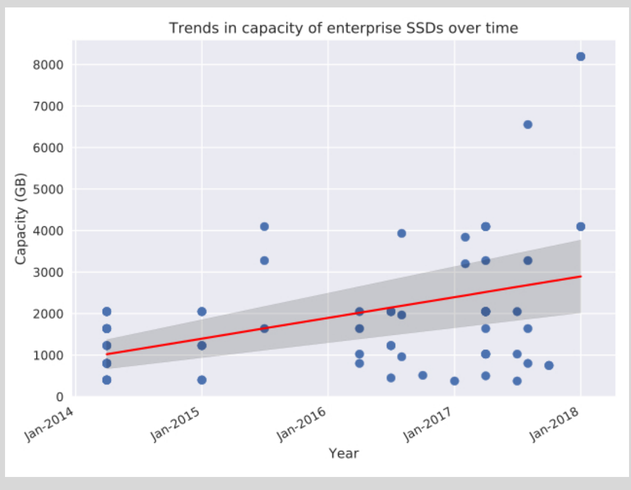
- Installed server base and datacenter capacity increasing every year.



- The ratio of power consumption at idle to full levels of utilization for blade servers shows a steady downwards trend, indicating an increase in energy proportionality and therefore energy efficiency.

- The power consumption for enterprise SSDs has remained at a steady rate, while the capacity of said SSDs has increased, showing again a trend towards more energy efficient offerings.





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