Northwest Power and Conservation Council

June 12, 2012

MEMORANDUM

TO: Power Committee

FROM: Massoud Jourabchi

SUBJECT: Data Center Loads in the Northwest - An update

Staff will present an update to the analysis of electric load from the data centers in the region. This presentation is an update to the work that was done in 2008 and 2009. That analysis showed there is about 600 MWa of connected load in all forms of data centers in the region. About half of this load was estimated to be in large custom data centers such as Facebook or Google data centers.

This presentation updates the trends in the demand for data center services, the trends in technological advances, and touches on the new loads from data centers coming into the region. The range of net load forecasts for the custom data centers, projected as part of the Sixth Power Plan, is found to be still valid and not changed in this update. However, if the projected efficiency improvements in the data center operations are not realized, or if their expansion in the region accelerates, the load for this market segment can increase significantly. Staff is working with PNUCC to encourage utilities to track the aggregated loads of large data centers specifically. This would help Council's work in tracking this potentially large customer class.

The presentation will also provide an update on data center energy efficiency and demand response activities. With effective power price signals, networks of custom data centers present an opportunity for demand response, because they can shift the timing of data processing requirements, a technique they call following the moon.

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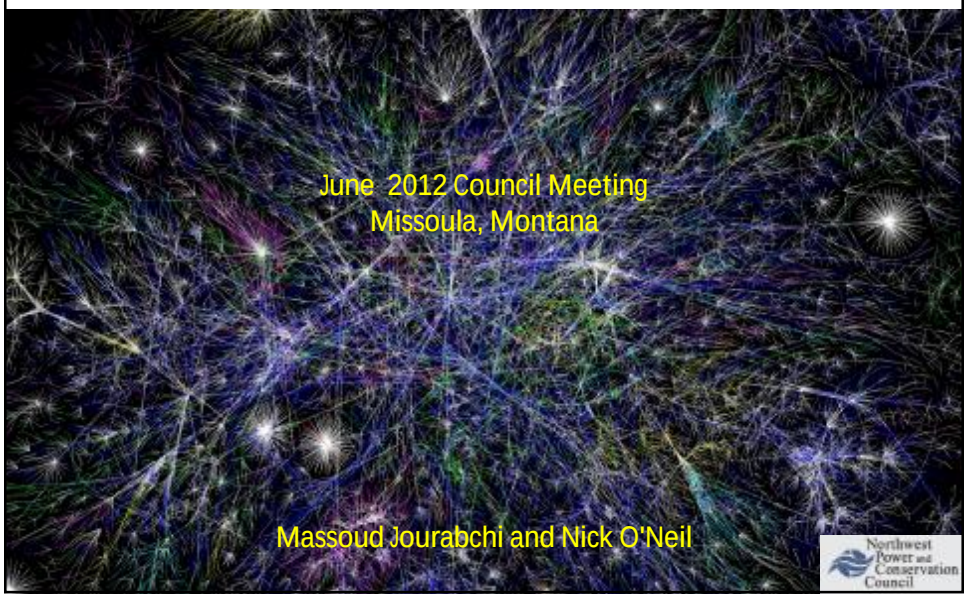
Energy Implications of Data Centers – An Update



In today's Presentation

- What is a data center and what are the types?
- Typical Electricity consumption of data center
- Current consumer and technology trends
- Conservation and DR potential
- Load Forecast
- Call for regional help

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What is a Data Center?

- A Data Center or server farm is a generic label for facilities that house:
  - Hardware
    - Servers (computers)
    - Storage Devices
    - Power backup Devices (PDC, and UPS)
    - Communication devices (Routers, Switches, etc)

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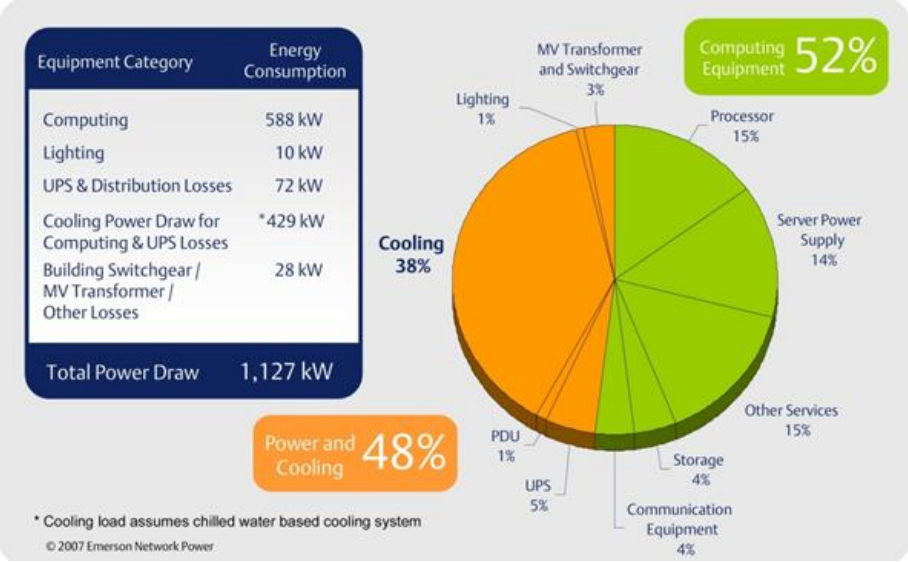
Data Center Types

Space Type	Example	Typical Size	Approximated Energy Consumption	Average # of Servers Per Location	% of Data Centers in the US	% of Servers in the US
Enterprise-class data center	Google, Facebook,	5,000+ ft2	10-250 MW	515	0.30%	28%
Mid-tier data center	Mid-size Facility, EasyStreet, ViaWest	<5,000 f2	0.5-10 MW	192	0.40%	15%
Localized data center	Hospital	<1000 ft2	10-500 kW	32	2.50%	16%
Server rooms	Mid-size company	<500 ft2	5-10 kW	3	45.10%	24%
Server closet	Small businesses, Council office	<200 ft2	<10 kW	2	51.80%	17%

- Data centers are not labor intensive
- They require large upfront capital
- Have to secure access to large amount of power, to be ready for quick expansion
- Often times, the connected load is much larger than actual load

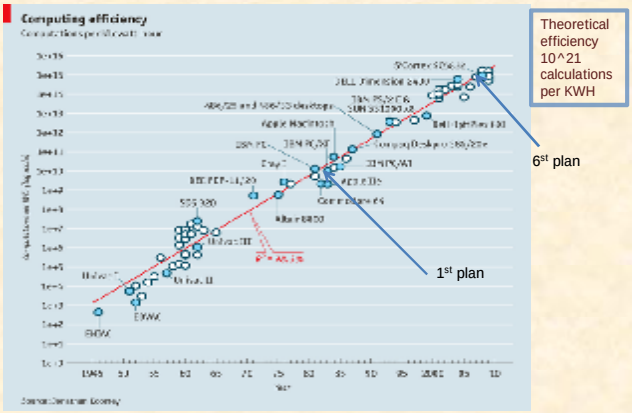
Extract from Data Center Market Assessment, Conducted by PECI, for Energy Trust of Oregon -2011

Power Distribution



Extract from Data Center Market Assessment, Conducted by PECI, for Energy Trust of Oregon -2011

Trend in power consumption suggest great gains in unit efficiency



Every decade computing efficiency increases by a factor of 100

More calculations per SQF of Data Center

Higher power consumption per SQF of Data Center

Newer computer processing is becoming more efficient.
By 2030, they are expected to be 10,000 times more efficient than today's processors.
Implication is for smaller, cooler processors, less power requirement, and more batteries which allow for separating application from power source, thus allowing for more off-peak charging of devices...

Although computing efficiency is increasing significantly, consumer trends for services is growing even faster

Prefixes	
Kilo	10^3
Mega	10^6
Giga	10^9
Tera	10^{12}
Peta	10^{15}
Exa	10^{18}
Zetta	10^{21}

Warning : The next few slides may be disturbing to some audience members.

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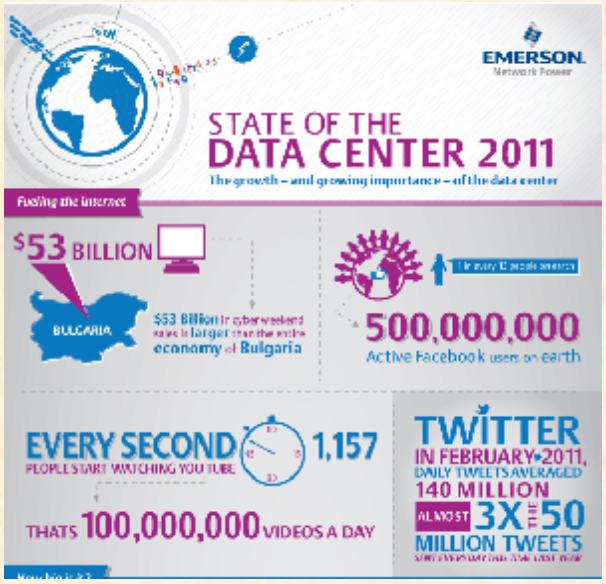
Consumer demand surpassed business demand by 2003



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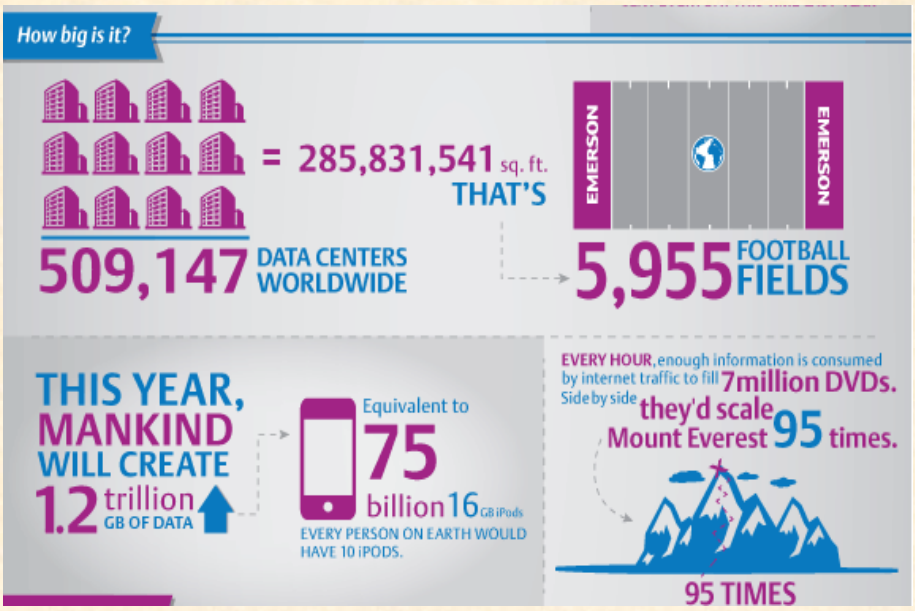

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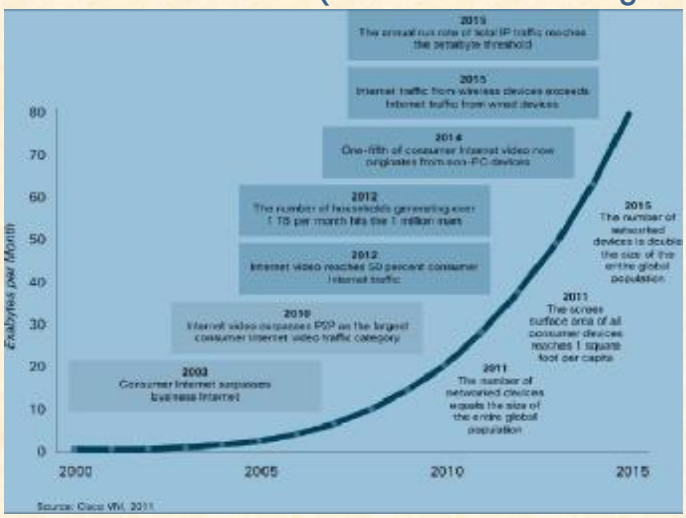
Potential growth in net traffic
A forecast (~30-40% annual growth)



Exabyte = 1,000,000,000,000,000,000 bytes
By 2015 forecast is for nearly a Zettabyte (10^21) per year.
By 2030 we could be well over a Yottabyte (10^24)/year

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The Northwest has a large share of data center

Currently over 60 enterprise and mid-tier facilities operate in the region

The Northwest in general, and Oregon in particular, is a prime site for data centers because of; cost and availability of electricity, good reliable transmission system, generous tax policies, educated workforce, good economic development incentive, and wonderful weather.

map from DataCenterMap.com April 2012

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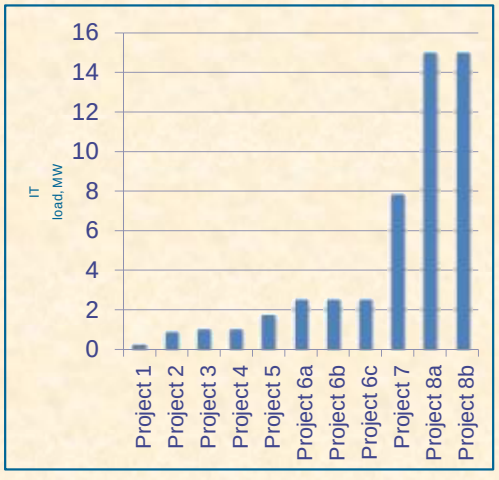
There is Room in the Data Centers to Save Energy



- Large/Enterprise Facility can save 10-20 million kWh per project
- Midsized, Dedicated Facilities can save 1-2 million kWh/project
- These savings are typically in the mechanical system
- There is even further efficiency gains by using virtualization to run the servers at higher capacity factor
- There is even opportunities of DR

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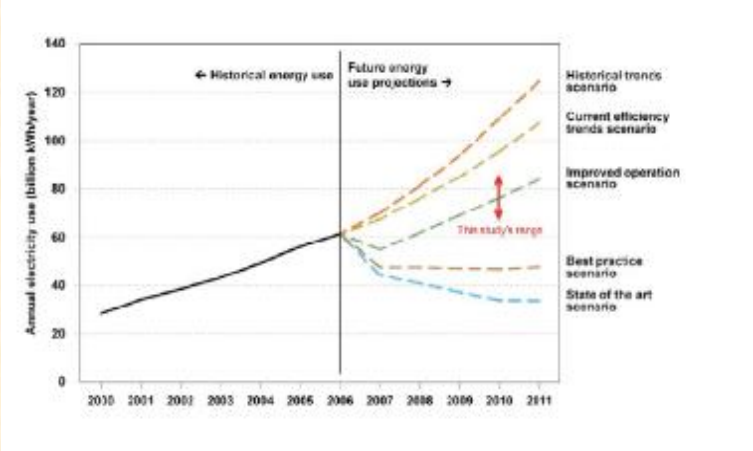
Real Opportunities for DR "Following the Moon"

Increasingly data centers need greater level reliability and security for their services. Replication of systems can occur across servers in a same location or across the world. Following the moon allows for reduced cooling energy requirement.

Future Load Forecast depends on the trajectory of efficiency



Growth in Data Center Electricity Use 2005 to 2010
J. Koomey Stanford university August 2011

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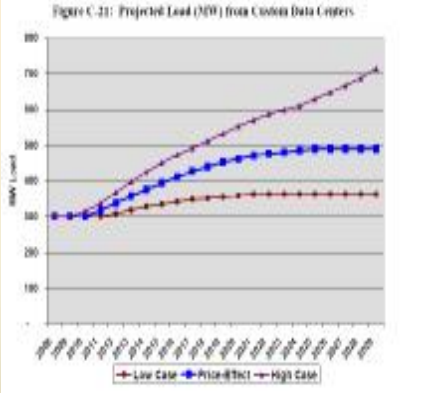
Regional Load* Forecast for Enterprise and Mid-tier Data Centers



Our forecast for 2012 is between 340-370 MWa

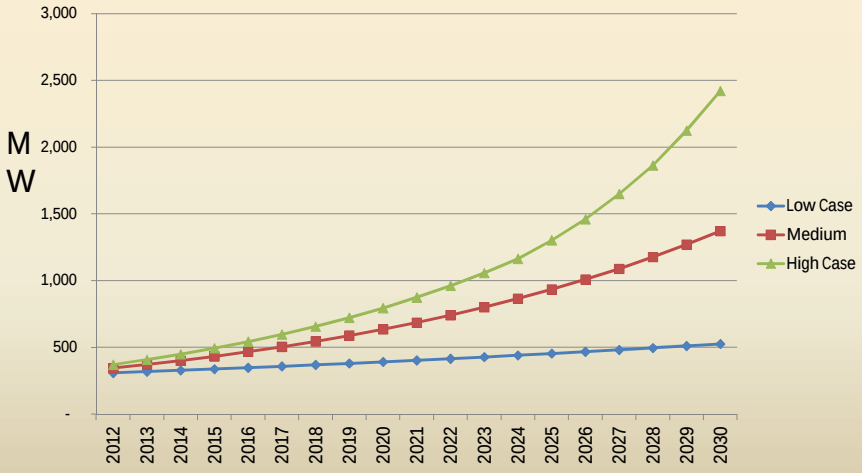
Depending on level of IT technological advancement, DSM and DR implementation

By 2020 load can be between 350-550 MWa

- **Actual additions to load are lumpy.**
- **Typically announced load is larger than actual load to allow for rapid expansion**

But What if technological advancements, DSM do not occur?

Data centers loads can be a significant share of regional load.



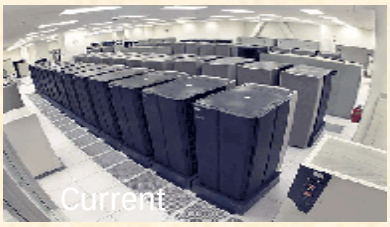
In Summary

- Data centers can provide
  - load growth
  - Good opportunity for DSM and DR
- Data Centers can become DSI of the future
- We Need for better understand of this customer
- We Need Council's support for encouraging
  - Establishment of baseline characteristics
  - Utilities to provide load forecast information

End of Presentation

- Additional slides - not part of the packet.

Past , Present and Future



Cloud Computing

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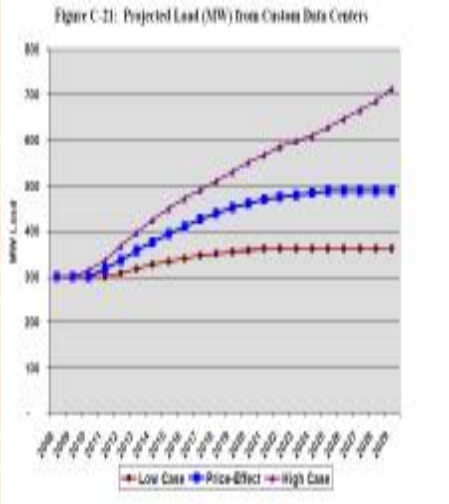
6th plan assumptions



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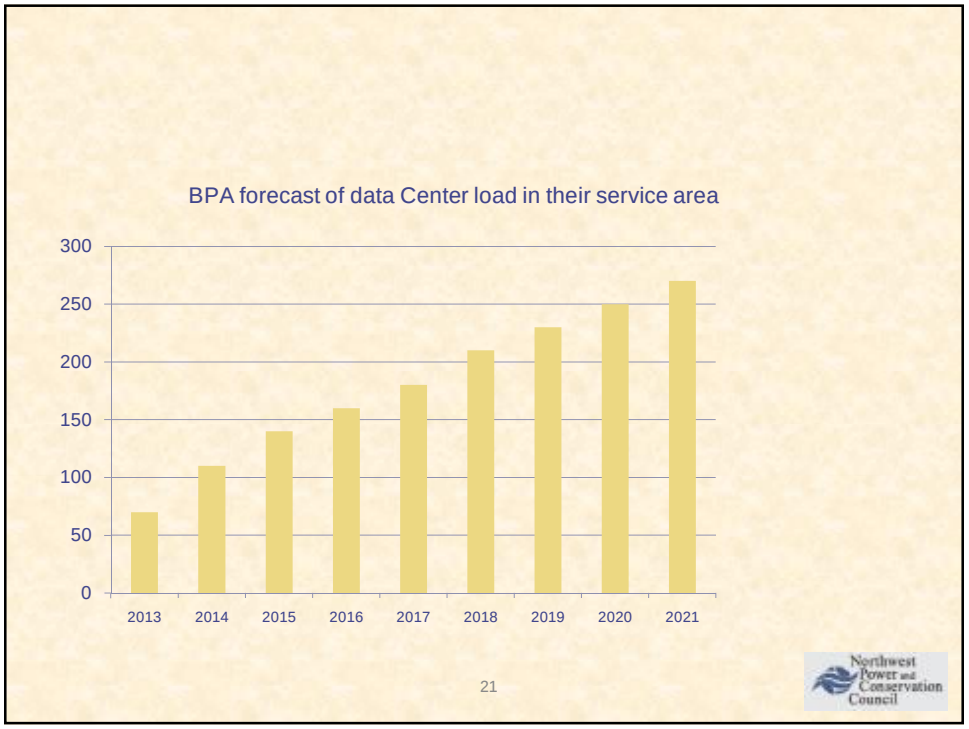
BPA forecast of data Center load in their service area
300
250
200
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
21
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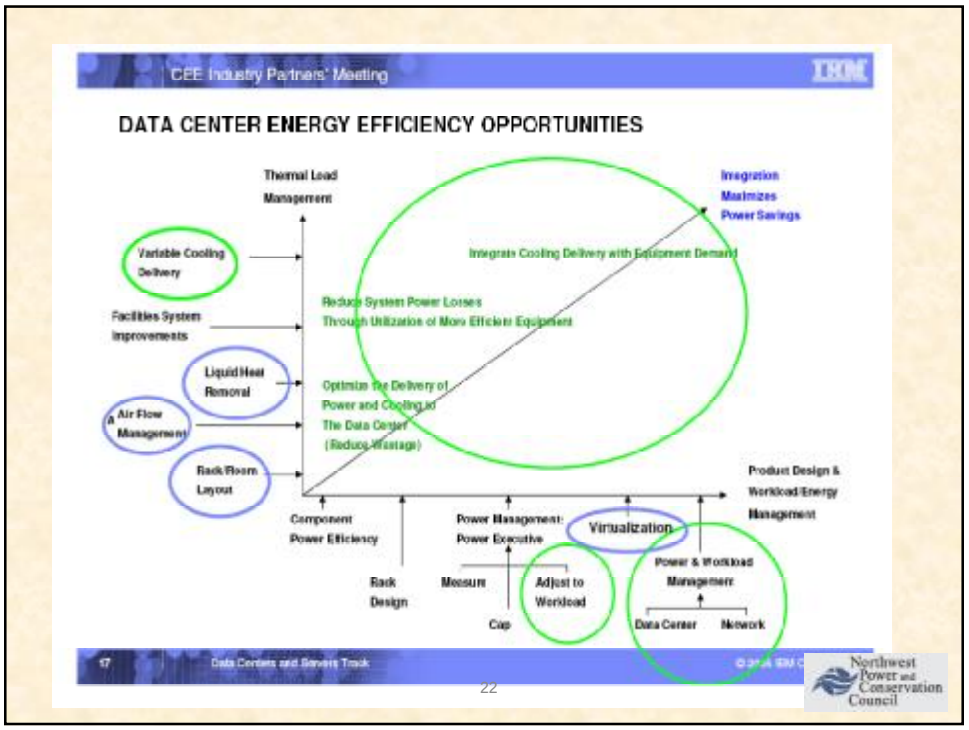
CEE Industry Partners' Meeting
IBM
DATA CENTER ENERGY EFFICIENCY OPPORTUNITIES
Thermal Load Management
Integration Maximizes Power Savings
Variable Cooling Delivery
Integrate Cooling Delivery with Equipment Demand
Facilities System Improvements
Reduce System Power Losses Through Utilization of More Efficient Equipment
Liquid Heat Removal
Optimize the Delivery of Power and Cooling to the Data Center (Reduce Wastage)
Air Flow Management
Rack/Room Layout
Product Design & Workload/Energy Management
Component Power Efficiency
Power Management: Power Executive
Virtualization
Rack Design
Measure
Adjust to Workload
Cap
Power & Workload Management
Data Center
Network
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Data Centers and Servers Track
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Some large Northwest data centers

Pending:
Hillsboro: Adobe Systems
Digital Realty Trust/NetApp
Fortune Data Centers
Quincy: Vantage Data Centers
Dell

DAN AGUAYO/THE OREGONIAN

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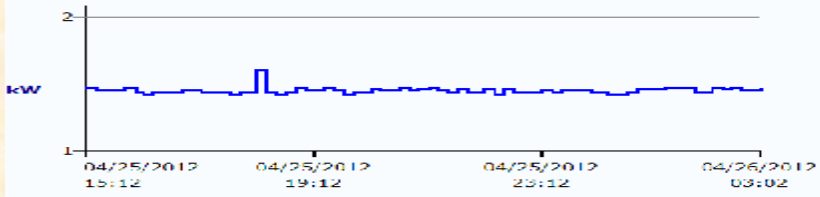
Typical daily Load Profile of a Closet Server



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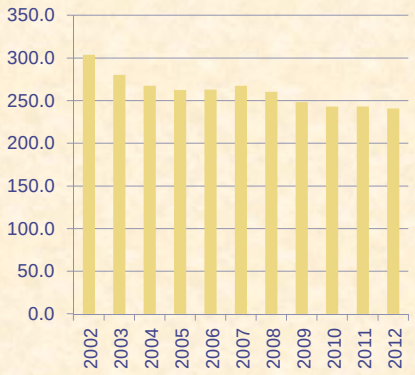
Nationwide

Employment in data processing, hosting and related services



- Information industry and data centers are not immune to economic cycles.
- As output of the industry goes up employment has not increased.

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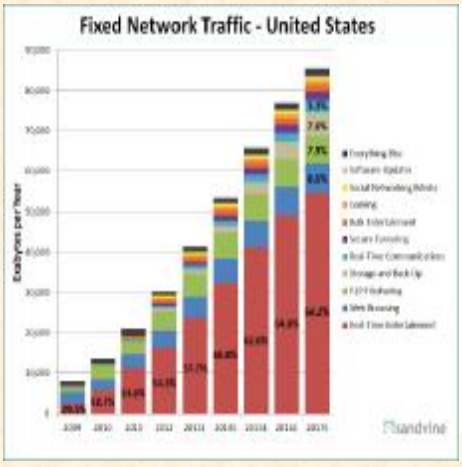
Potential Growth in demand

Another similar forecast



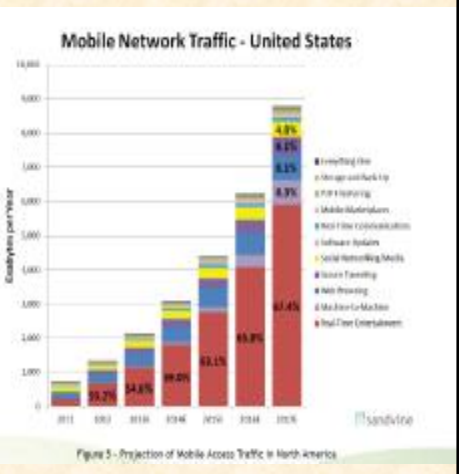


Figure 5 - Projection of Mobile Access Traffic in North America

Exabyte

1000,000,000 gigabytes 10^{18} bytes

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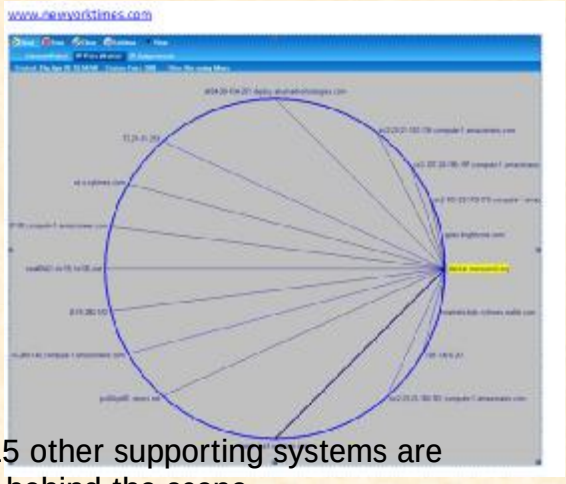
\What happens when you go to

The New York Times

Tuesday, May 1, 2012

Newyorktimes.com



At least 15 other supporting systems are activated behind the scene.

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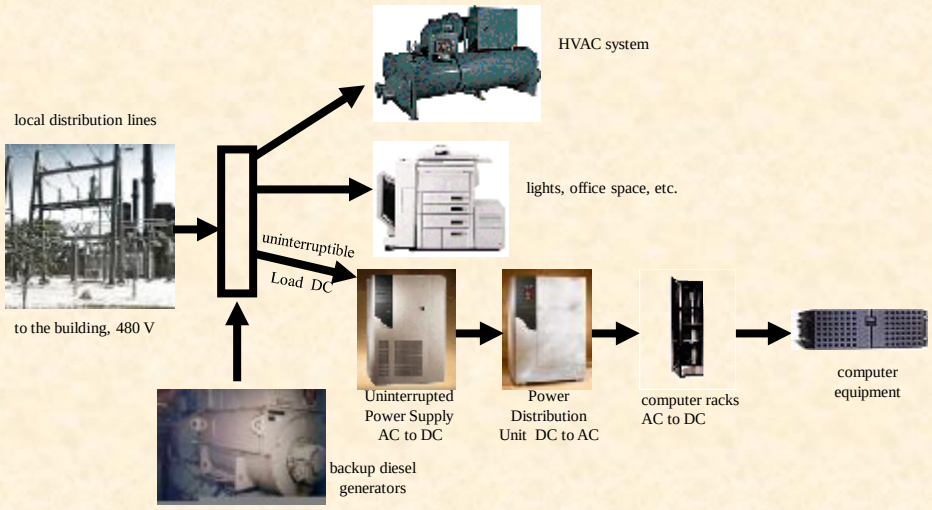
Electricity Flows in Data Centers



Jonathan Koomey, Ph.D.
Lawrence Berkeley National Laboratory

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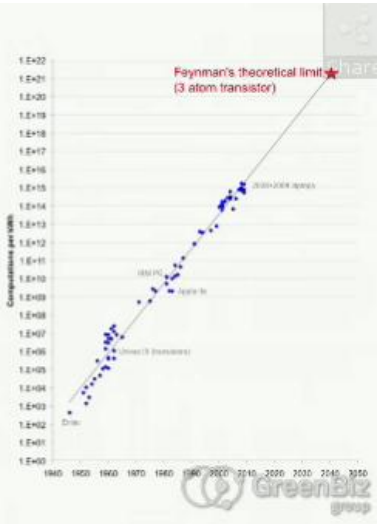
These trends still have a long way to run



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Data centers have wide geographic footpring

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Forecast of Data Center Loads
Enterprise and Mid-tier

Table C-17: Medium Case Trends in Data Center Loads

	Growth in Demand	Increase in Efficiency	Load MWa
2010-2011	0%	0%	302
2012	7%	-1%	318
2013	7%	-1%	337
2014	7%	-2%	354
2015	7%	-2%	372
2016	7%	-3%	389
2017	7%	-3%	402
2018	7%	-4%	418
2019	7%	-4%	428
2020	7%	-5%	435
2021	7%	-5%	444
2022	7%	-5%	448
2023	7%	-6%	453
2024	7%	-6%	457
2025-2030	7%	-6%	462

	Low Case	Price Effect	High Case
2008	300	300	300
2009	300	300	300
2010	300	300	315
2011	300	318	337
2012	309	337	367
2013	318	367	397
2014	328	375	425
2015	331	394	459
2016	341	410	473
2017	348	426	491
2018	351	439	511
2019	355	452	532
2020	358	461	553
2021	362	470	569
2022	362	475	586
2023	362	480	598
2024	362	485	610
2025	362	489	628
2026	362	489	647
2027	362	489	667
2028	362	489	687
2029	362	489	714
2030	362	489	743

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