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.
Energy Implications of Data Centers
– An Update

June, 2012 Council Meeting
Missoula, Montana

Massoud Jourabchi and Nick O’Neill

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
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)

Data Center Types

- 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

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Example</th>
<th>Typical Size</th>
<th>Approximated Energy Consumption</th>
<th>Average # of Servers Per Location</th>
<th>% of Data Centers in the US</th>
<th>% of Servers in the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise-class data center</td>
<td>Google, Facebook, EasyStreet, ViaWest</td>
<td>5,000+ ft²</td>
<td>10-250 MW</td>
<td>515</td>
<td>0.3%</td>
<td>28%</td>
</tr>
<tr>
<td>Mid-tier data center</td>
<td>Mid-size Facility, EasyStreet, ViaWest</td>
<td>&lt;5,000 ft²</td>
<td>0.5-10 MW</td>
<td>192</td>
<td>0.4%</td>
<td>15%</td>
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<tr>
<td>Localized data center</td>
<td>Hospital</td>
<td>&lt;1000 ft²</td>
<td>10-500 kW</td>
<td>32</td>
<td>2.5%</td>
<td>16%</td>
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<tr>
<td>Server rooms</td>
<td>Mid-size company</td>
<td>&lt;500 ft²</td>
<td>5-10 kW</td>
<td>3</td>
<td>45.1%</td>
<td>24%</td>
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<tr>
<td>Server closet</td>
<td>Small businesses, Council office</td>
<td>&lt;200 ft²</td>
<td>&lt;10 kW</td>
<td>2</td>
<td>51.8%</td>
<td>17%</td>
</tr>
</tbody>
</table>

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

Consumer demand surpassed business demand by 2003.
Potential growth in net traffic
A forecast (~30-40% annual growth)

Exabyte = 1,000,000,000,000,000,000,000 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
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

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
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
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

1970s

Current

Cloud Computing

6th plan assumptions

Figure C.21: ProjectedLoad (MW) from Custom Data Centers

Low Case | Price Effect | High Case
BPA forecast of data Center load in their service area

DATA CENTER ENERGY EFFICIENCY OPPORTUNITIES
Some large Northwest data centers

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

Quincy: Microsoft, intuit, Yahoo, Sabey
Hillsboro: Intel
The Dalles: Google
Boardman: Amazon
Prineville: Facebook

EAN AGUAYO/THE OREGONIAN

Typical daily Load Profile of a Closet Server
- Information industry and data centers are not immune to economic cycles.
- As output of the industry goes up, employment has not increased.

Potential Growth in demand
Another similar forecast

Exabyte

1000,000,000 gigabytes = $10^{18}$ bytes
At least 15 other supporting systems are activated behind the scene.

Electricity Flows in Data Centers

Jonathan Koomey, Ph.D.,
Lawrence Berkeley National Laboratory
These trends still have a long way to run.

Data centers have wide geographic footprint.
### Forecast of Data Center Loads

#### Enterprise and Mid-tier

<table>
<thead>
<tr>
<th>Year</th>
<th>Low Case</th>
<th>First Ecol.</th>
<th>High Case</th>
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#### Table C.17: Median Case Trends in Data Center Loads

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<th>Year</th>
<th>Growth in Demand</th>
<th>Increase in Efficiency</th>
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