Northwest Power and Conservation Council

July 30, 2013

MEMORANDUM

TO: Council Members

FROM: Massoud Jourabchi

SUBJECT: Overview of Data Centers

As part of Council's ongoing monitoring activities in the region, this staff presentation will cover a general overview of data centers.

Staff will present an update to the analysis of electric load from the data centers in the region. 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. During 2012 and over the first six months of 2013, the region witnessed an increase in large data center loads. Our earlier analysis put the load for large data centers in 2012-2013 at about 300-400 MW. This year's update increases that estimate to about 550 MW. This puts the region on a high load growth trajectory for data centers. It should be noted this 550 MW figure includes estimates of loads for large custom data centers such as Facebook and Google, data centers and mid-tier data centers such as; Viawest, Fortune Data Centers and Digital Realty Trust, and RackSpace which provides collocation services, but excludes smaller localized data centers loads.

Update on Data Centers in the Northwest

Data Centers Bloom Where Beans Once Grew

August 6th 2013

In today's Presentation

- ▣ Review of what is a data center & their sizes and functions
- ▣ Why Northwest is a favorite destination for large Data Centers.
- ▣ Current consumer and technology trends
- ▣ Load Forecast
- ▣ Conservation and DR potential
- ▣ Repeat of call for regional help

New Names in the NW Energy Landscape

QUINCY DATA CENTERS

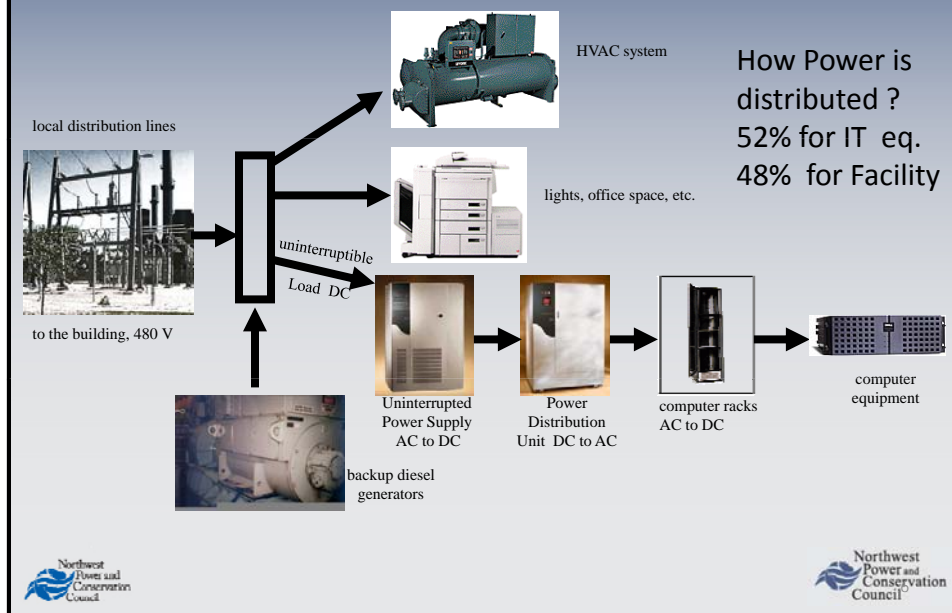**ViaWest, Rackspace, Intuit, Vantage, Vmware,......** 3
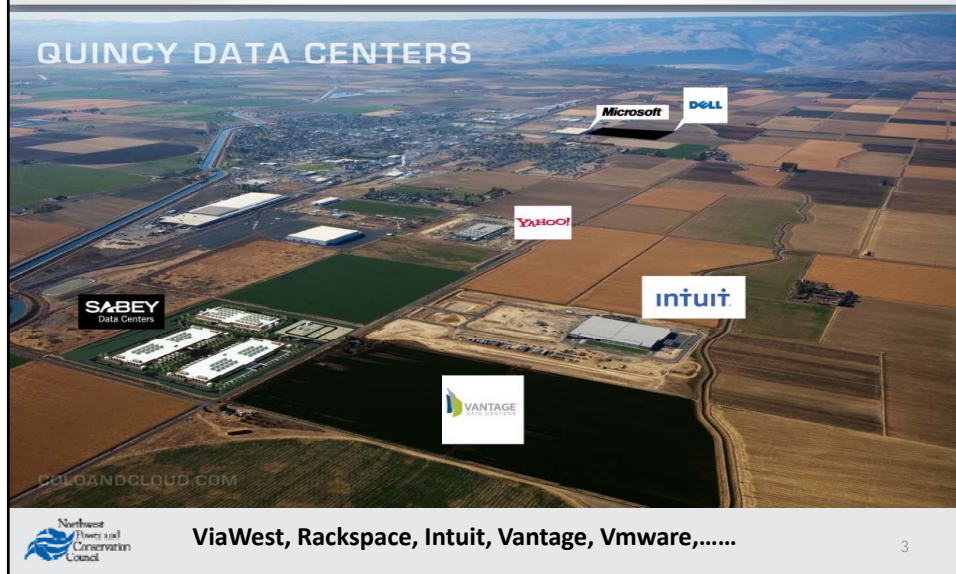
What is a Data Center?

A Data Center or server farm is a generic label for facilities that house:

▫ IT Hardware
  ▫ Servers (computers)
  ▫ Data storage devices
  ▫ Power supply, conditioning & backup systems
  ▫ Communication devices (routers & switches)
▫ HVAC equipment that serves the hardware
▫ Lighting that serves the resident staff

There are a variety of data center sizes

Space Type	Example	Typical Size	Approximated Energy Consumption	Average # of Servers	% of Data Centers	% of Servers in the
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,	<200 ft2	<10 kW	2	51.80%	17%

Electricity Flows in Data Centers

HVAC system

How Power is distributed ?
52% for IT eq.
48% for Facility

local distribution lines

to the building, 480 V

uninterruptible
Load DC

lights, office space, etc.

Uninterrupted
Power Supply
AC to DC

Power
Distribution
Unit DC to AC

computer racks
AC to DC

computer
equipment

backup diesel
generators

Northwest
Power and
Conservation
Council

Larger Enterprise/Custom Data Centers are typically located in Smaller Towns

Some large Northwest data centers

Wenatchee: VMWare
Olympia
Quincy: Microsoft, Intuit, Yahoo, Sabey, Vantage Data Centers, Dell
WASH.
Umatilla: Amazon
Boardman: Amazon, Rackspace (pending)
Hillsboro: Portland
Intel
Adobe Systems
VIAWest
Fortune Data Centers
Digital Realty Trust/NetApp
The Dalles: Google
ORE.
Prineville: Facebook, Apple

DAN AGUAYO/THE OREGONIAN

•Access to cheaper land

Access to Communication networks

•Access to Power

•Access to economic development incentives

•Allowing for rapid expansion of loads

7

Data Center Loads in the NW 2011-2012

Large Data Center loads in the region represent about 5% -10% of non-DSI industrial sales

- 350 to 500 average megawatts
- As much electricity as lumber & wood products
- About half as big as Oregon's pulp and paper sector

Smaller Data Centers loads within commercial buildings represent roughly 5%-6.5% of commercial sector sales

- About 300 to 400 average megawatts

**How will the future load from Data Centers unfold?**

8

What Drives Future Demand For Data Center Services?

- **Social and Technological Trends**
  - Social Networking
  - On-Demand Video
  - Unknown New Applications & Services
  - Private and public clouds
  - Ultra-low power monitoring

Northwest
Power and
Conservation
Council

9

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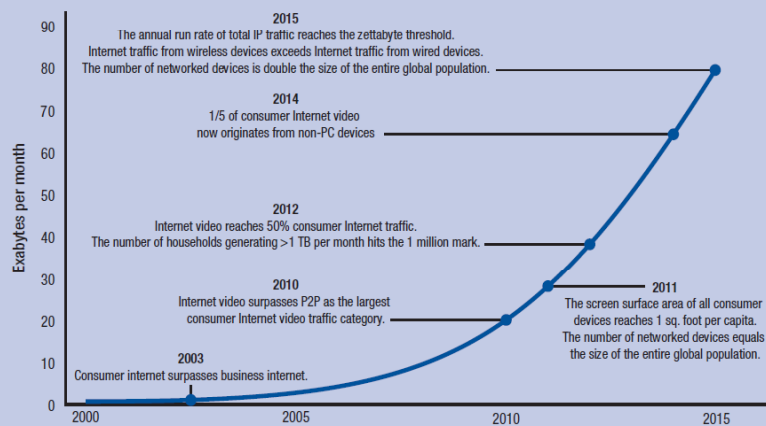

Exabyte = 10^15 bytes

Source: Cisco, 2011

Demand For Data Storage

- **Facebook**
  - 240 billion pictures in storage
  - 350 million pictures added per day
  - 82% of traffic is to access 8% of photos (hot storage)
  - 200 billion of photos not accessed frequently (cold Storage)

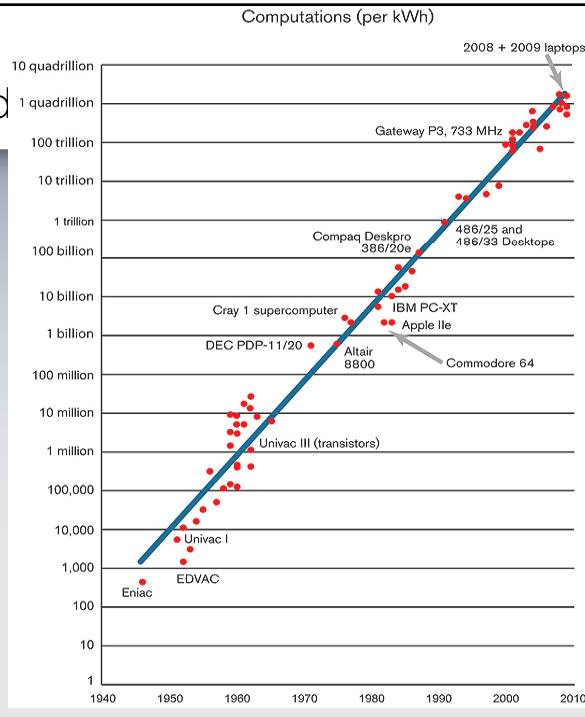**IT Storage Capacity at Council's Main Office (GB)**

	1990	1994	1996	2000	2004	2008	2012
■ Capacity (GB)	1	12	70	120	522	5,000	6,000

11
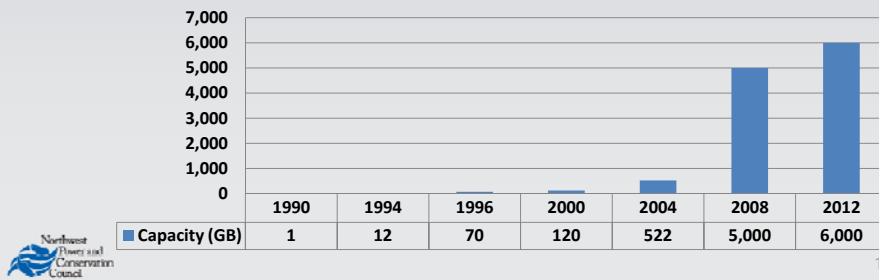
Processing Efficiency Trend

Computations (per kWh)

- Computations per kWh have doubled about every year and a half since the 1940s

- 100 fold improvement every decade

- Enabled the existence of laptops and smart phones

2008 + 2009 laptops

Gateway P3, 733 MHz

486/25 and 486/33 Desktope

Compaq Deskpro 386/20e

IBM PC-XT

Cray 1 supercomputer

Apple IIe

DEC PDP-11/20

Altair 8800

Commodore 64

Univac III (transistors)

Univac I

EDVAC

Eniac

What if you applied this efficiency increase to the auto industry ?

1971 – 81 MPH
2012 – 324,000 MPH   Speed Increase

1971 – 26 MPG
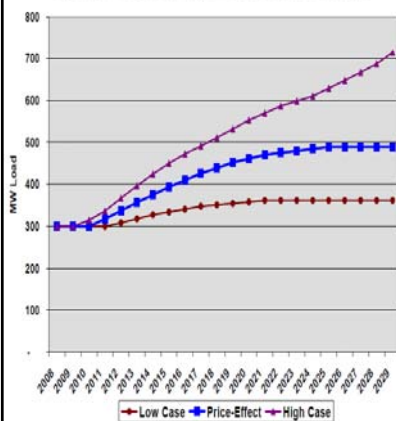*2012* – 130,000 MPG   Energy Efficiency

1971 – $2,500.00
2012 – $0.05   Cost

Lorie Wigle
Eco-Technology General Manager, Intel
Corporation

13

Source: Volkswagen 1971 Super Beetle Brochure

What can we expect for region loads: Forecast for Enterprise and Mid-tier Data Centers

Figure C-21: Projected Load (MW) from Custom Data Centers

Low Case — Price-Effect — High Case

For Council's 6th power plan, forecast was for between 350-700 MWa growth for large data centers.

If efficiency is not incorporated in the data centers, loads can go significantly higher. Potentially as large as the past Aluminum industry in the region with loads in excess ~2500 MWa. Or over half the current industrial sales.

During development of the Seventh Power Plan we will be updating these forecast.

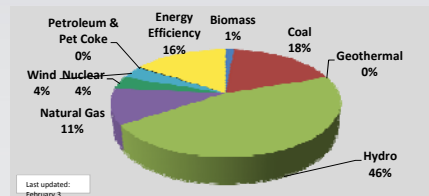Preliminary indications suggest higher loads than 6th plan.
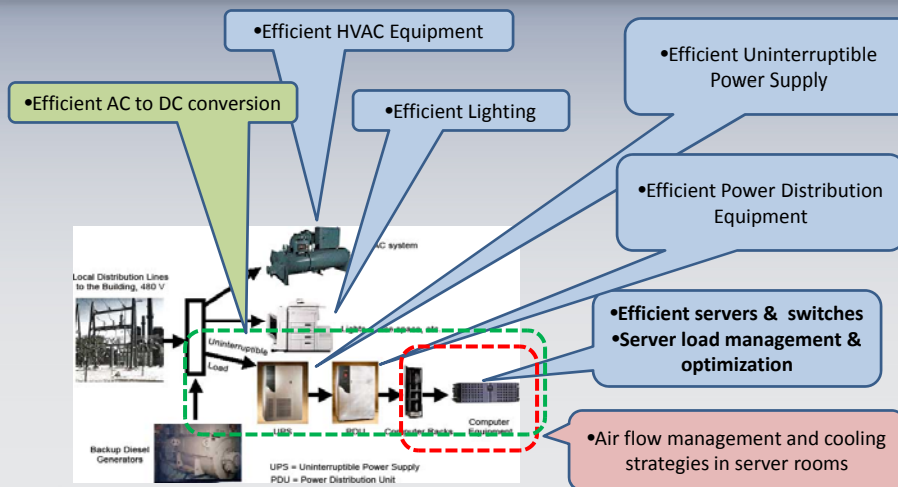
What Powers Data Centers?

- Conventional Grid Electric Utility
- Small amounts from other sources
  - On site solar & wind
  - Off site renewable purchases
  - Combined Heat & Power
  - Waste heat recovery
  - Backup Generators

Facebook has built solar array next to its new data center in Prineville, Oregon

Last updated: February 3, 2012

15

Where is the EE Potential in Facilities?

- Efficient HVAC Equipment

- Efficient Uninterruptible Power Supply

- Efficient AC to DC conversion

- Efficient Lighting

- Efficient Power Distribution Equipment

Local Distribution Lines to the Building, 480 V

Uninterruptible Load

Backup Diesel Generators

UPS = Uninterruptible Power Supply
PDU = Power Distribution Unit

- **Efficient servers & switches**
- **Server load management & optimization**

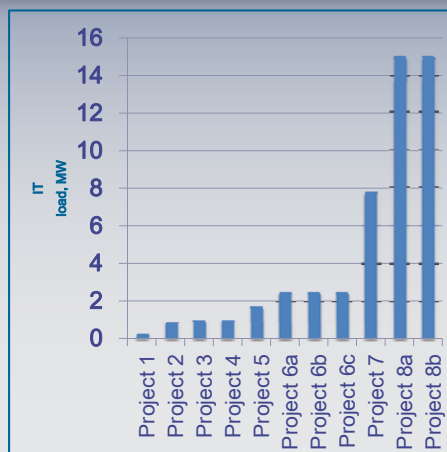- Air flow management and cooling strategies in server rooms

16

IT Sector Efficiency Potential in the Sixth Power Plan

- **No potential in large data center facilities**
  - Large facilities have built-in EE incentives
  - In 2009 no utility programs for large facilities
  - Put efficiency improvements in forecast
  - Likely change assumption for Seventh Plan
- **Significant potential in small facilities**
  - Server rooms & closets in embedded in commercial buildings
  - Server virtualization (88 average megawatts)
  - Likely expand measures list in Seventh Plan

17

Some Examples of Utility Program Savings

New Construction
- Finding about 10% savings over baseline
- Most common:
  - High efficiency HVAC
  - High efficiency UPS

- It does not take many projects to generate savings. Energy Trust of Oregon estimates an annual load reduction of 30 million kWh per year from 5 projects.

Existing facilities
- Decommissioning outdated equipment
- Virtualization consolidate/run servers at higher capacity factor
- Measuring and reporting on performance on the IT and facility side

Handful of examples from ETO.

Data Center and Efficiency

- **Data Centers infustructure enables displacement of less efficient economic activities.**
- **Data Center efficiency is increasingly becoming the top concern for IT and facility managers.**
- **About 60% of the data center mangers indicated that they have already analyzed efficiency or are currently analyzing efficiency in their facilities.**

19

Grid Support Services

- **Microgrid applications**
  - Backup generation and local integration of renewables
  - Automated decoupling
- **Ancillary Services**
  - Increase and decrease load for balancing
  - Move load based on grid congestion
- **Data centers can be extremely flexible loads given sufficient incentive**

In summary

- Connected load for data centers is in the hundreds of MWs in the PNW and growing fast
- Data Centers are enabling the economy and society to increase their efficiency
- Technology and industry structure change rapidly
- Forecasting data center loads has high uncertainty
- Unknowable future presents significant risks & opportunities for the electric utility industry
- Many sources of low-cost efficiency measures
- Mixed motivation to pursue efficiency
- Efficient facilities will reduce utility uncertainty
- Partnerships between data center operators, designers, trade associations and utilities could provide valuable synergies
- Council needs help from utilities and IT industry to keep up to speed on this fast growing sector

Northwest
Power and
Conservation
Council

21