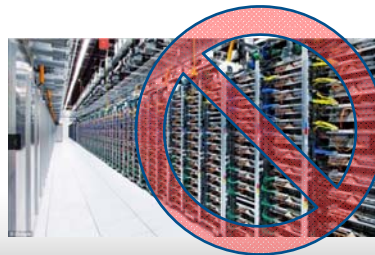


Embedded Data Centers

CRAC November 13, 2014



Data Centers within Commercial Buildings Exclude Dedicated DC Buildings



Embedded Data Center Project

- **Contract to build model of Embedded DC**
 - Load & Conservation Potential
 - Contractor: Cadmus & Eric Masanet
- **Based on preliminary CBSA data 2013**
 - Included key data on DC characteristics
- **Functional model based on 2011 study**
 - Masanet, E., Brown, R.E., Shehabi, A., Koomey, J.G., and B. Nordman (IEEE 2011)

Estimated Count of Data Centers

Size Description	Minimum Size SF	Maximum Size SF	Number of Data Centers in PNW
Server closet	0	99	21,000*
Server room	100	749	22,000*
Localized data center	750	1,999	900*
Mid-tier data center	2,000	19,999	600*
Co-Location	2,000	19,999	70
Enterprise	20,000	Max	15

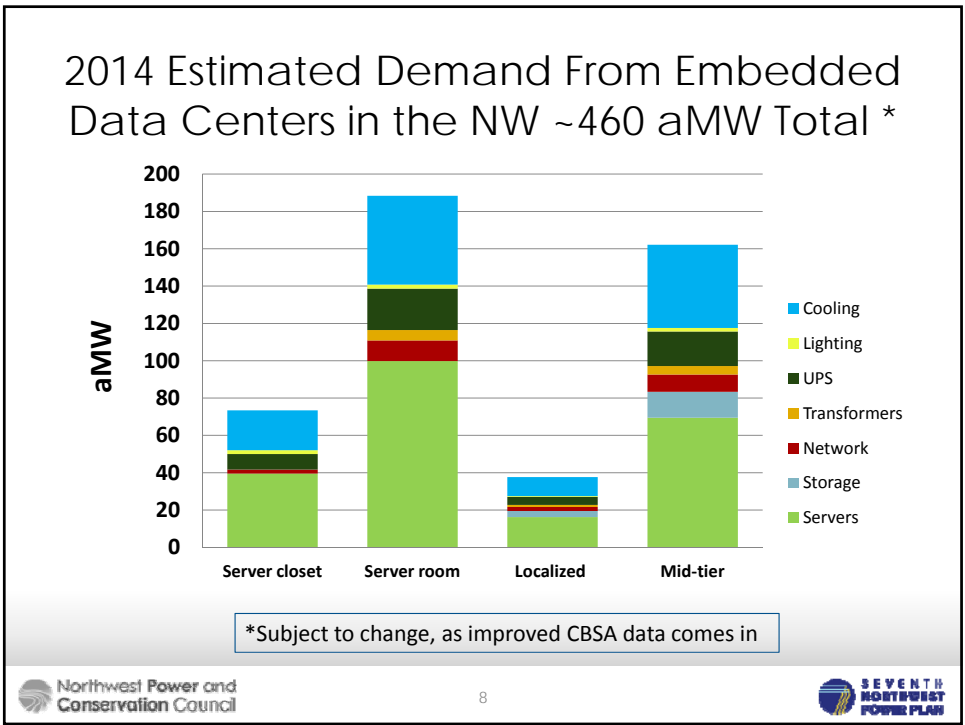
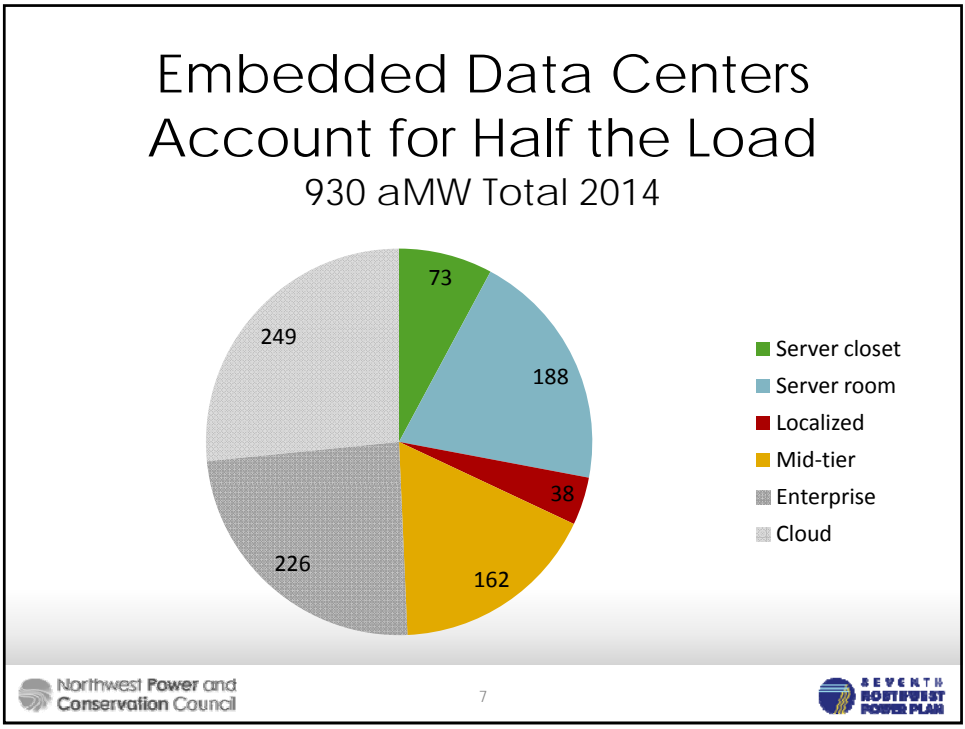
* Preliminary: Based on preliminary CBSA data. Will update

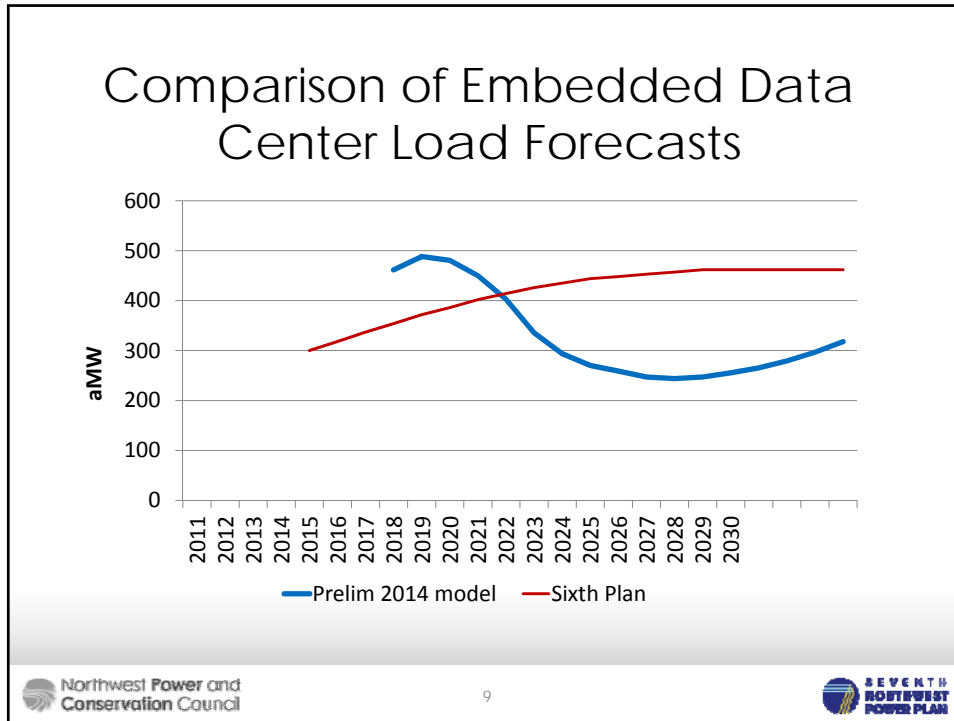
CBSA Findings*

- **One-third of buildings had Embedded Data Centers**
 - 230 buildings with 260 EDC out of 750 sites sampled
- **ENERGY STAR servers about 36%**
- **Virtualization**
 - 35% of Embedded DC use some
 - 21% virtualized overall
- **Cooling system type & capacity**
 - About 50% EDC on dedicated cooling systems


* Preliminary: Based on preliminary CBSA data. Will update

Preliminary Model Results







Drivers of Embedded Data Center Energy Use



- Demand for IT service growing fast
- IT device efficiency growing faster


10


IT Traffic Drivers

Traffic type	Compound Annual Growth Rate (2013-2018)
All IP traffic	20%
Internet video traffic	27%
Web, email, and data traffic	16%
File sharing traffic	8%
Business IP traffic	20%

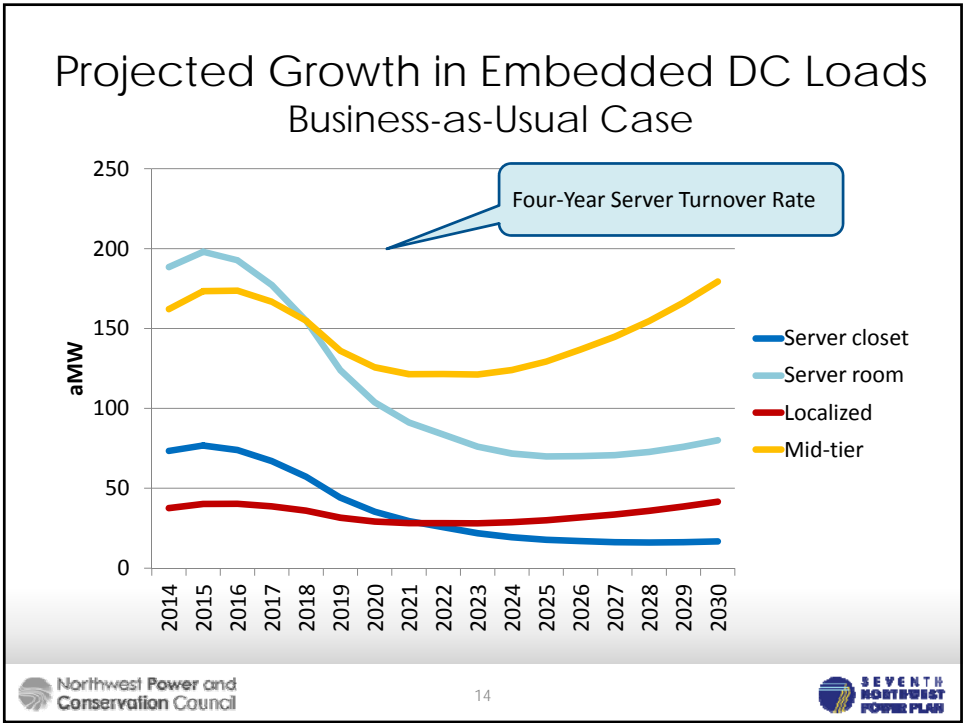
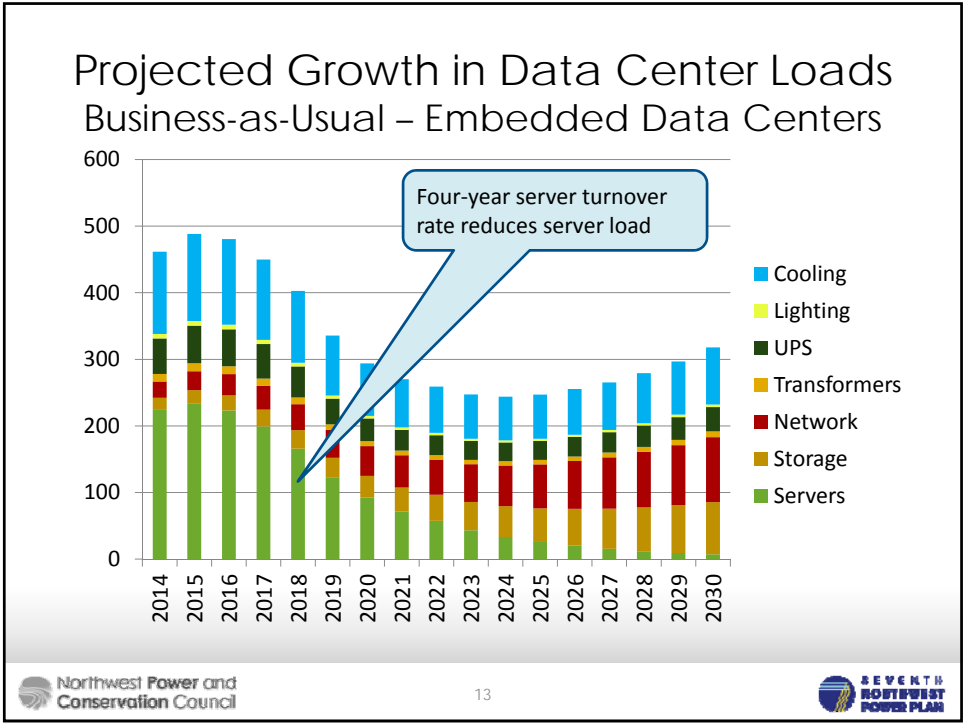
Cadmus Model
Uses This

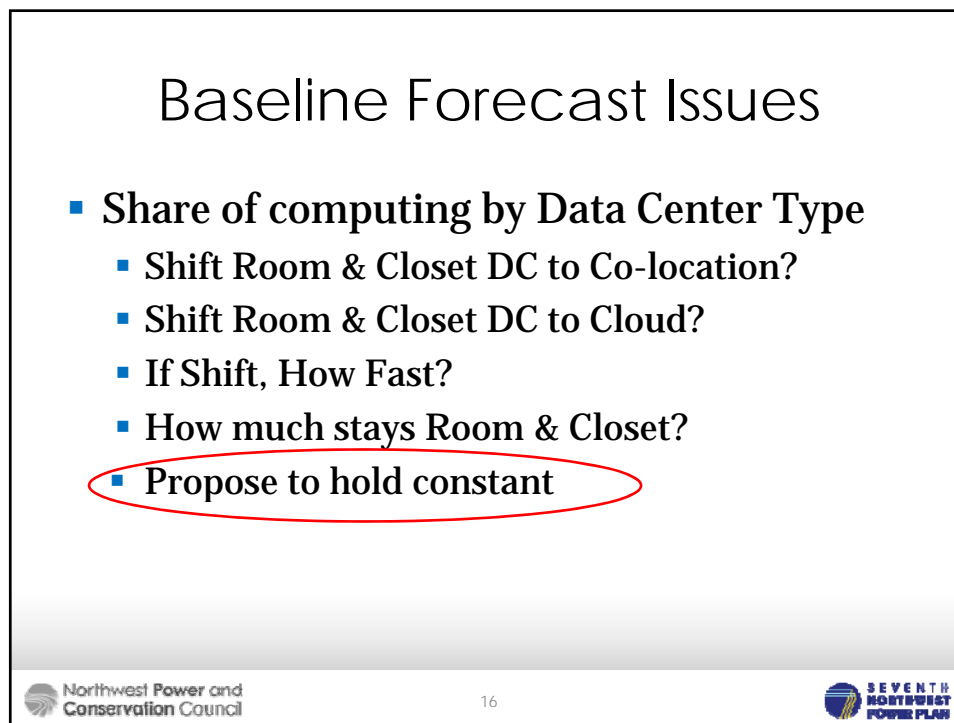
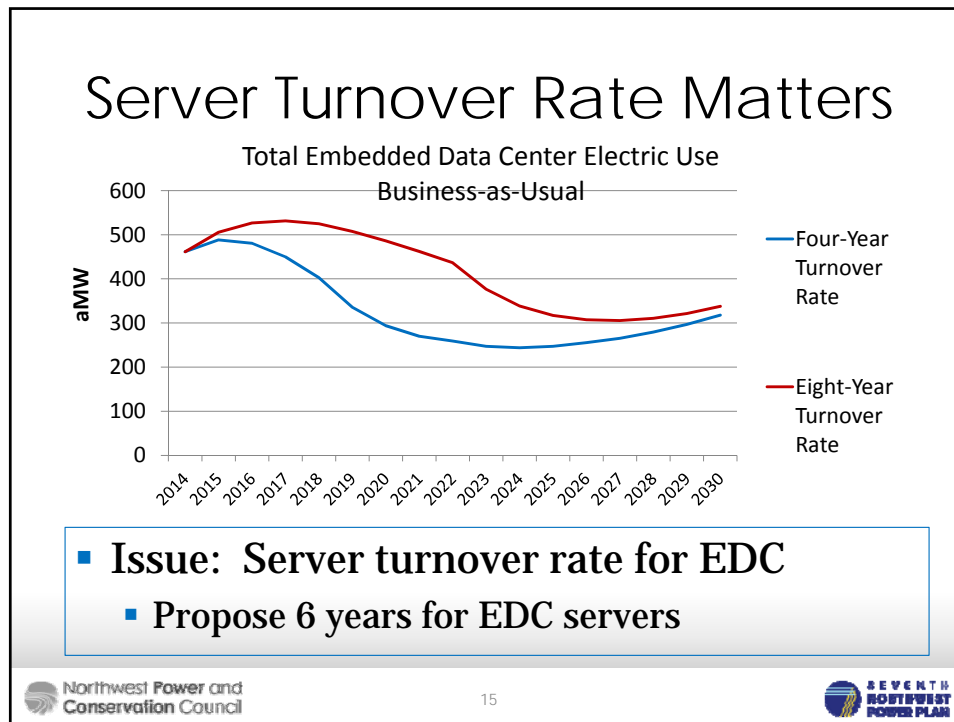
Source: Cisco 2014

IT Device Efficiency Drivers

Parameter	Compound Annual Growth Rate
Server computations	41% *
Server computations per watt	56% **
HDD areal density	12%
HDD storage TB per watt	10%
Network gear GB capacity	10%
Network GB per watt	11%

* Moore's Law
** Koomey's Law



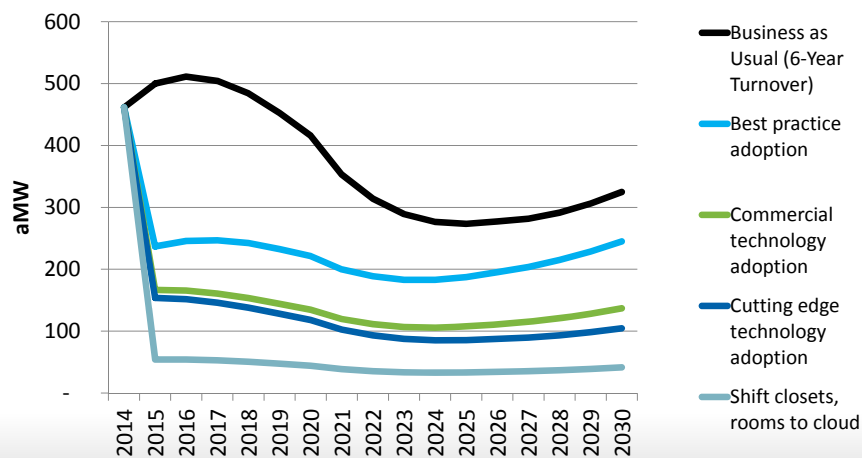


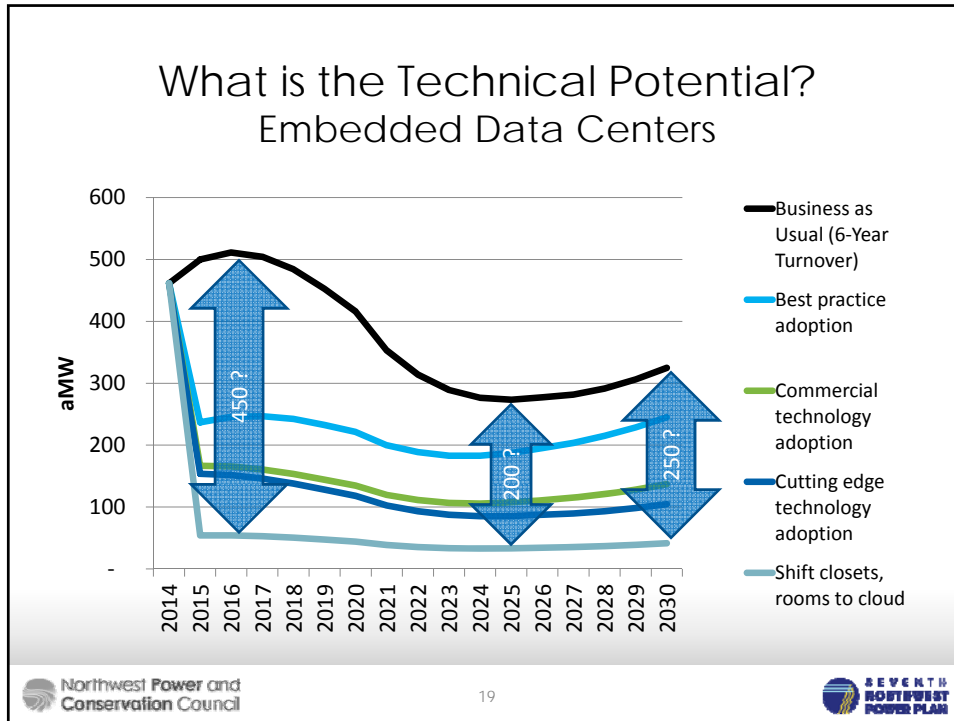
Efficiency Measures

- Remove zombie servers
- Device reduction
- Change to ENERGY STAR servers
- Virtual Operating System
- Power Management enabled (PM)
- Increase capacity utilization
- Improve Power Use Efficiency (PUE)
- Improve storage
- Move to The Cloud

Efficiency Scenarios include increasing degrees of adoption of these measures.

If We Could Shift Technology Overnight? Embedded Data Centers





- ### Conservation Issues: Need CRAC Feedback
- **Proposal: Limit to Embedded DC only**
 - Large facilities have business case to be efficient
 - **Technical Potential**
 - Propose 6-year turnover for EDC servers
 - Savings potential measured mid-plan 2025
 - **There are viable utility program models**
 - IT equipment focus
 - Upstream: IT Vendors, OEMs, Retailers
 - ENERGY STAR, Targeted Virtualization
 - **Achievable 85%**
- Northwest Power and Conservation Council 20 SEVENTH NORTHWEST POWER PLAN

Embedded Data Centers Preliminary*

Parameter	Sixth Plan	Seventh Plan (draft)
Number of Embedded Data Centers	Unknown	43,000*
Estimated PNW Load <u>All</u> Data Centers (aMW)	600 (2010)	960 (2014)*
Estimated PNW Load <u>Embedded</u> Data Centers (aMW)	~300 (2010)	~460 (2014)*
Technical Potential (aMW over 20 years)	130 (Virtualization)	~200 to 250 *
Levelized Cost (\$/MWh)	(-\$60)	Very low

* Will update with final CBSA data