U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Hydrogen & Fuel Cells for Data Center Applications: Meeting Introduction

Dr. Ned Stetson, Program Manager, Fuel Cell Technologies Office

Hydrogen and Fuel Cells for Data Center Applications Project Meeting

March 20, 2019 – Seattle Washington

Key Introductions

- Organizers
  - Genevieve Saur – NREL
  - Dimitrios Papageorgopoulos - DOE
  - Ned Stetson – DOE
- Breakout Sessions
  - David Peterson – DOE
  - Vanessa Arjona – DOE
  - Amberlie Clutterbuck – DOE
  - Eric Parker – DOE
- Hotel and Meeting Logistics
  - Stacey Young

Energy Demand for Data Centers

Data Centres Of The World Will Consume 1/5 Of Earth's Power By 2025

By João Marques Lima | PUBLISHED: 05:30, 12 December, 2017 | UPDATED: 00:32, 12 December, 2017

Alarming new research suggests that failure to source renewable energy could make data centres one of the biggest polluters in just seven years.

Source: Data-Economy: Data Centres Of the World Will Consume 1.5 of the Earth's Power by 2025 (https://data-economy.com/data-centres-world-will-consume-1-5-earths-power-2025/)

Growth of Data Center Installed Capacity

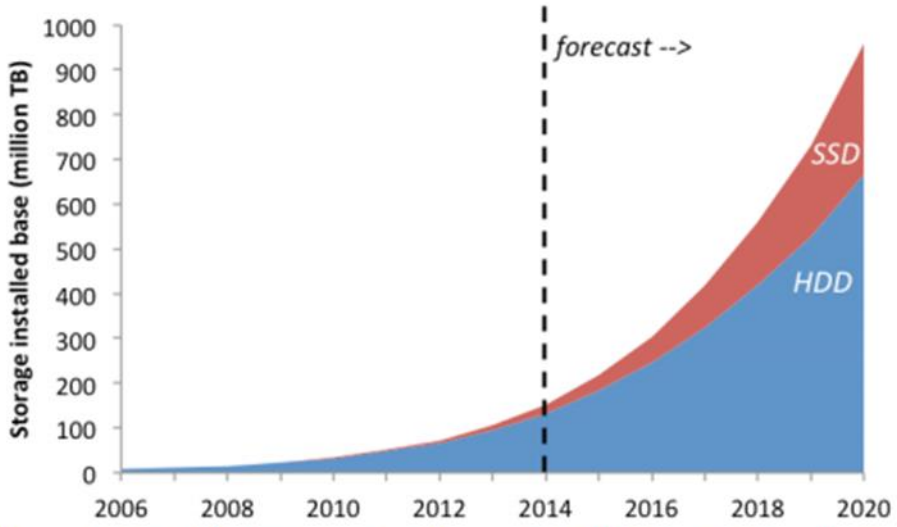


Figure 12. Total U.S. Data Center Storage Installed Base in Capacity (TB)

Projected growth is primarily for large "Hyperscale" Data Centers

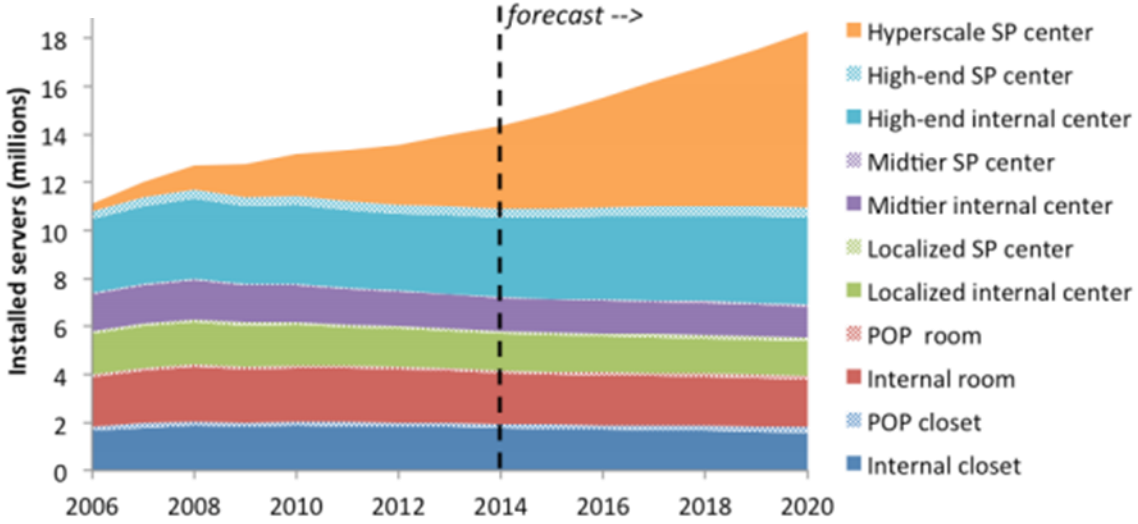


Figure 20. Total Server Installed Base by Data Center Space Category

Source: *United States Data Center Energy Usage Report* – June 2016 (Lawrence Berkeley Lab) – (https://www.osti.gov/servlets/purl/1372902/)

Electricity Consumption and Improvement in PUE

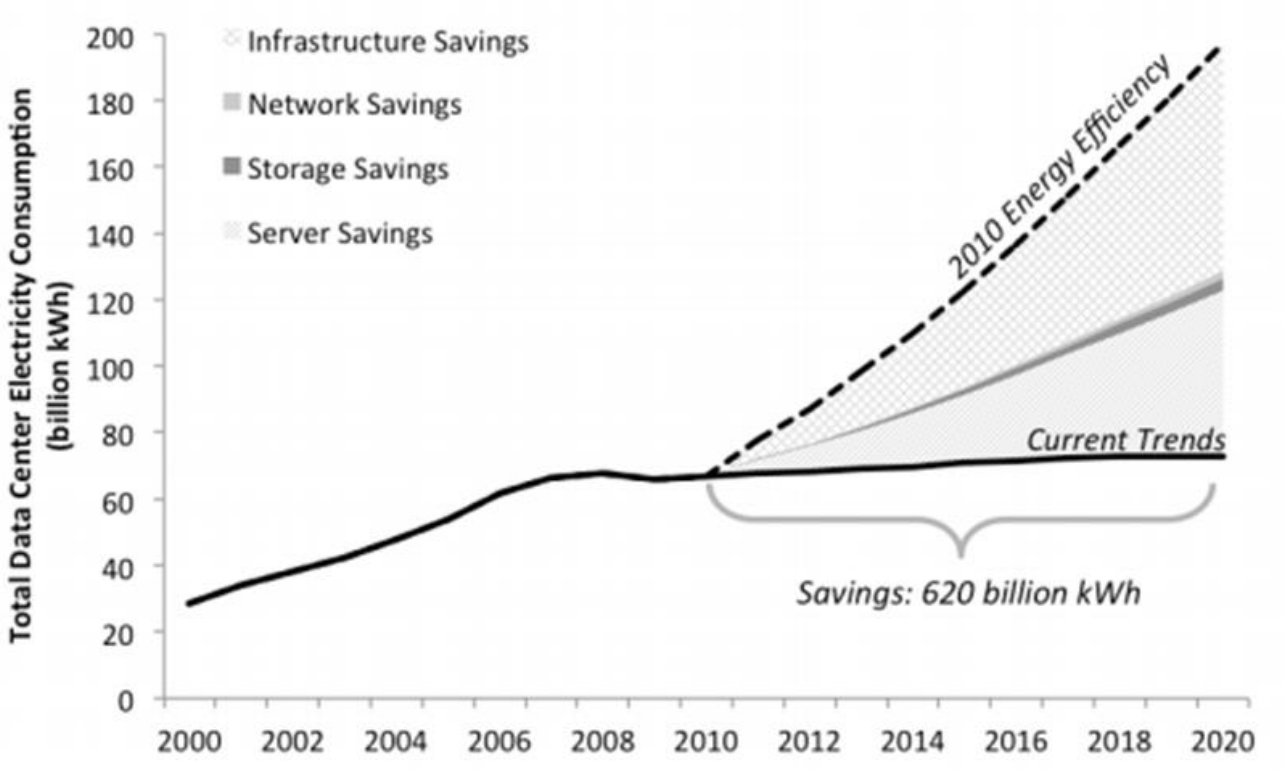


Figure 24. Data Center Electricity Consumption in Current Trends and 2010 Energy Efficiency Scenarios

The 2010 Energy Efficiency scenario assumes that data center energy-related design and operational efforts do not continue past 2010, which indicates that current trend energy efficiency practices will have saved 620 billion kWh of electricity over the period 2010-2020.

Source: *United States Data Center Energy Usage Report* – June 2016 (Lawrence Berkeley Lab) – (https://www.osti.gov/servlets/purl/1372902/)

Electricity Consumption and Improvement in PUE

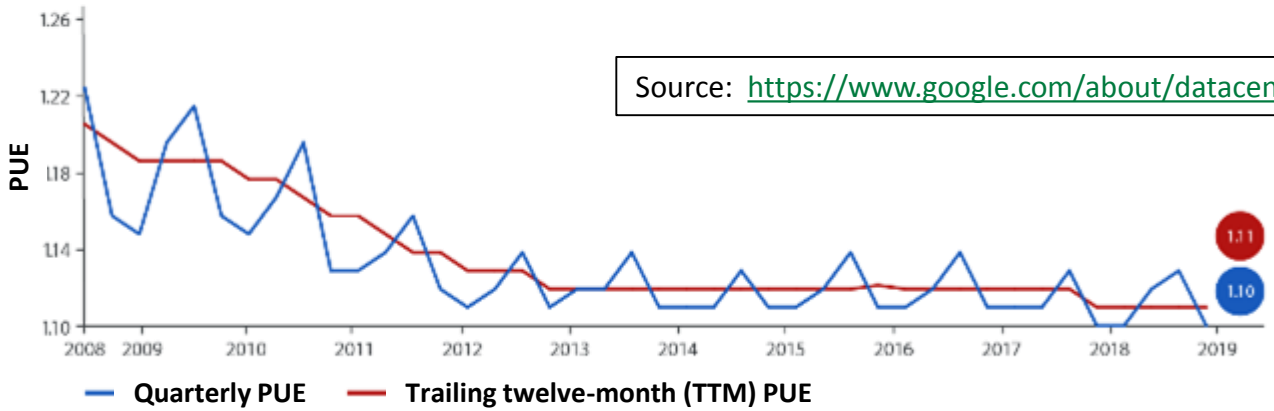
Table 6. PUE and Redundancy Values for Efficiency Scenarios

Space Type	2014 PUE	2020 PUE			Redundancy
		Current Trends	Improved Management	Best Practices	
Closet	2.0	2.00	2.00	2.00	N+0.5N
Room	2.5	2.35	1.70	1.50	N+1
Localized	2.0	1.88	1.70	1.50	N+1
Midtier	1.9	1.79	1.70	1.40	N+0.2N
High-end	1.7	1.60	1.51	1.30	N+0.5N
Hyperscale	1.2	1.13	1.13	1.10	N

Source: *United States Data Center Energy Usage Report* – June 2016 (Lawrence Berkeley Lab) – (https://www.osti.gov/servlets/purl/1372902/)

Continuous PUE Improvement

Average PUE for all data centers



Source: https://www.google.com/about/datacenters/efficiency/internal/

Figure 2: PUE data for all large-scale Google data centers

Objectives

- Assess the application of hydrogen and fuel cell technologies for primary and/or back-up power for data centers
  - Initiate dialog between data center industry stakeholders and hydrogen and fuel cell industry stakeholders
  - Identify key areas hydrogen and fuel cell technologies can provide benefit to data center design and operation
  - Identify critical technology gaps where further R&D is needed
- Expected outcomes will help:
  - Identify opportunities and barriers for adoption
  - Identify R&D activities to help enable adoption