State of Data Centers in the Northwest Load Forecast 2022-2030

Panel 10 : Energy

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Massoud Jourabchi

Greenway Research Group LLC

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here

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In this presentation

- Some Definitions
- Overview of global demand and regional markets
- Energy components of a data center
- Drivers and Trends for Data Center Usage
- Long-term Forecast of Demand for Power ☺

Some Definitions

Types of Data Centers* (*excluding crypto-mining*)

- Embedded Data Centers: server closet, server room
- *Colocation Data Centers: Real Estate sites with data center services, typically in urban setting*
- *Hyperscale Data Centers: Google, AWS, Apple…, typically in rural setting*
- Edge Computing: Distributed data processing close to point of use

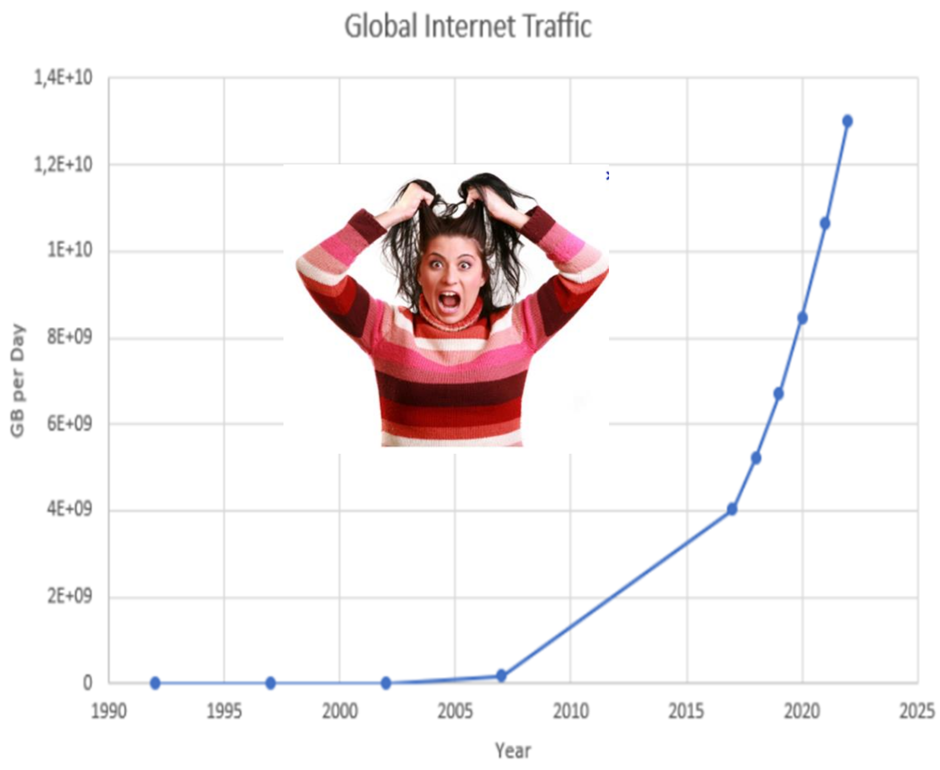
- IP traffic: the flow of data across the internet. IP Traffic is also commonly referred to as web traffic.
- Moore Law: observation that the number of transistors on computer chips doubles approximately every two years.
- Koomey Law: observation that the number of computations per joule of energy doubled about every 1.57 years.
- PUE : Ratio of electricity use for data services to total facility electricity consumption

- EB: Exabyte is equal to 10^18 bytes or one billion gigabytes (GB)
- ZB: Zettabyte is equal 10^21 bytes

A Day in life of Data*

- 500 million tweets are sent
- 294 billion emails are sent
- 4 petabytes of data are created on Facebook
- 4 terabytes of data are created from each connected car
- 65 billion messages are sent on WhatsApp
- 5 billion searches are made
- 12,000,000,000 GB of Internet traffic Per Day
- By 2025, it's estimated that 463 exabytes of data will be created

each day globally – that's the equivalent of 212,765,957 DVDs per day

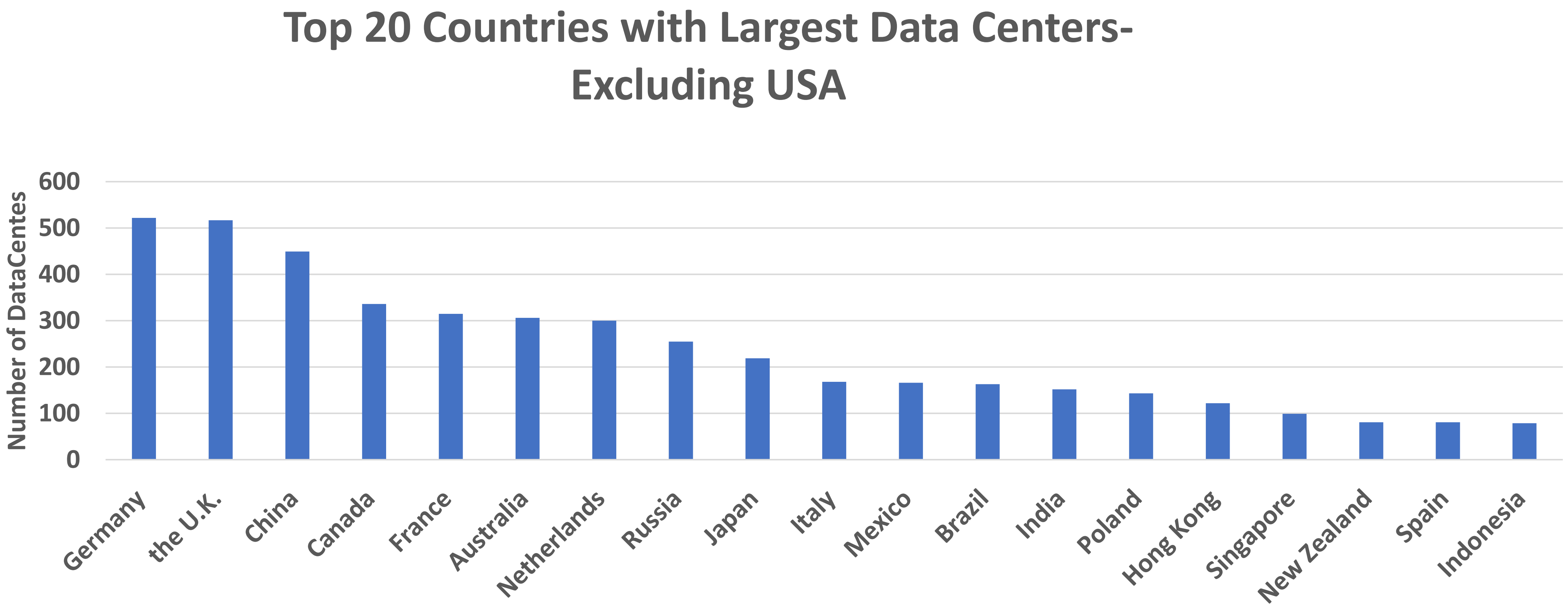


2: Increase in Global Internet Traffic in GB per Day from 1997 to 2022 (data from [Cisco, 2018])

Source: Visual Capitalist - https://www.visualcapitalist.com/how-much-data-is-generated-each-day

To meet the data hunger more and more data centers are born

USA has over 5,300 Large Data Centers that is more than the top 19 countries combined



Typically there is a 4-5 years construction cycle for Data Centers.

Power Consumption of Large Data Centers in USA

Market Geography	Sum of Capacity (MW)
Northern Virginia	2552
Dallas	654
Phoenix	615
Silicon Valley	615
Chicago	555
New York City - Northern New Jersey	392
Portland	382
Atlanta	360
Los Angeles	206
Salt Lake City	203
Las Vegas	173
Seattle	105
Boston	95
Denver	78
Columbus	41
Grand Total	7026

Partial list.

Nationally power consumption of data centers is estimated at 9% of total electrical consumption in 2023.

Although share of electricity demand from large data centers has grown from 1.5% to 9%, and growing at 11% annually. Nationally demand for electricity has been flat, indicating gains in efficiency in other sectors.

	2006	2021	2023	AAGR
Total US Electrical Consumption (TWH)	3660*	3800*	3680*	0.03%
Hyperscale Data Centers (TWH)	61	175	375	11%
% of National	1.5%	5%	9%	

*- LBL National Assessment of Large data centers

Northwest was an earlier destination for Data Centers

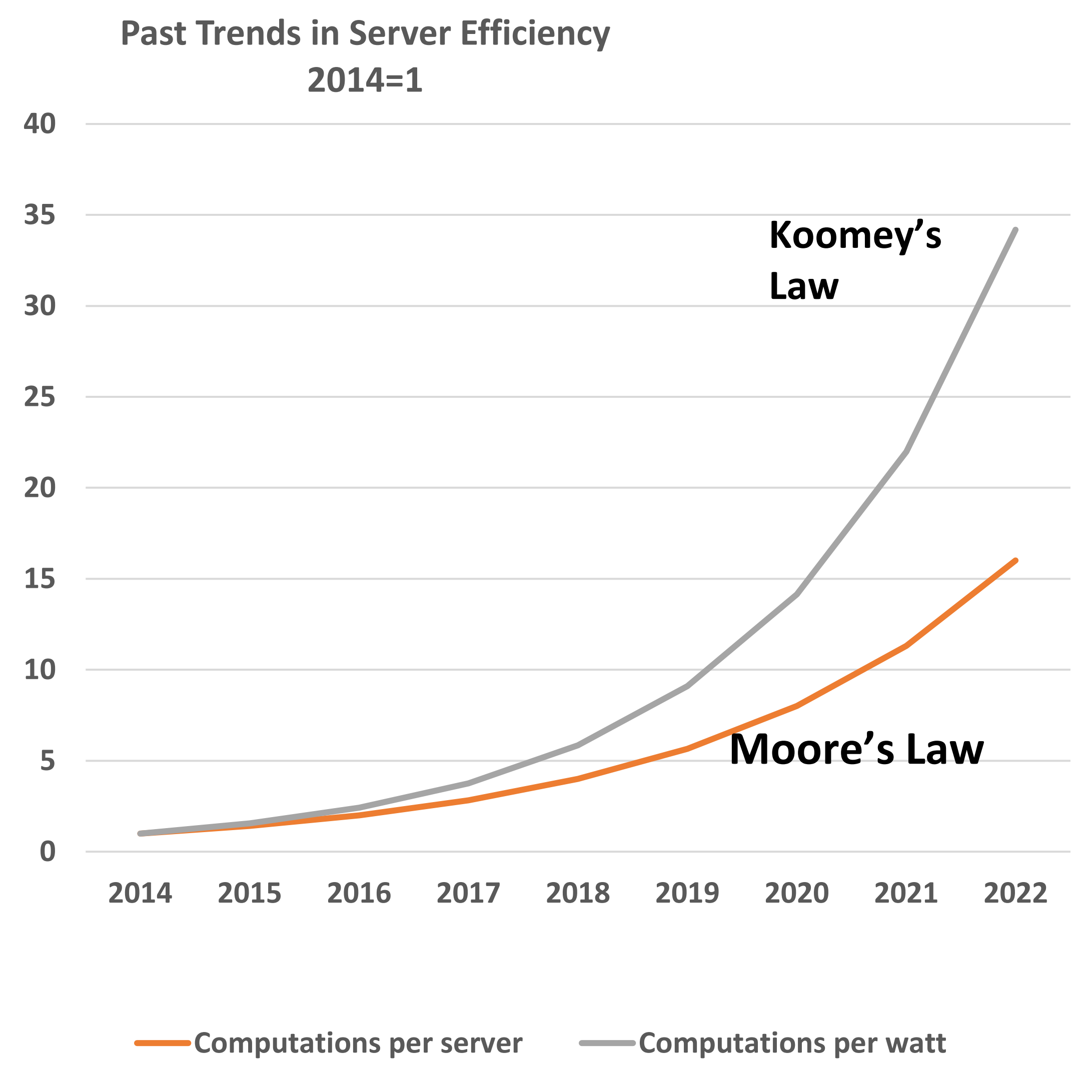
In part because of:

- **Ample power, (in part due to departure of large industrial customers)**
- **Low power and land cost,**
- **Availability of high speed communication,**
- **Reliability of power,**
- **Good reliable transmission system,**
- **Generous tax policies,**
- **Educated workforce,**
- **Wonderful weather**

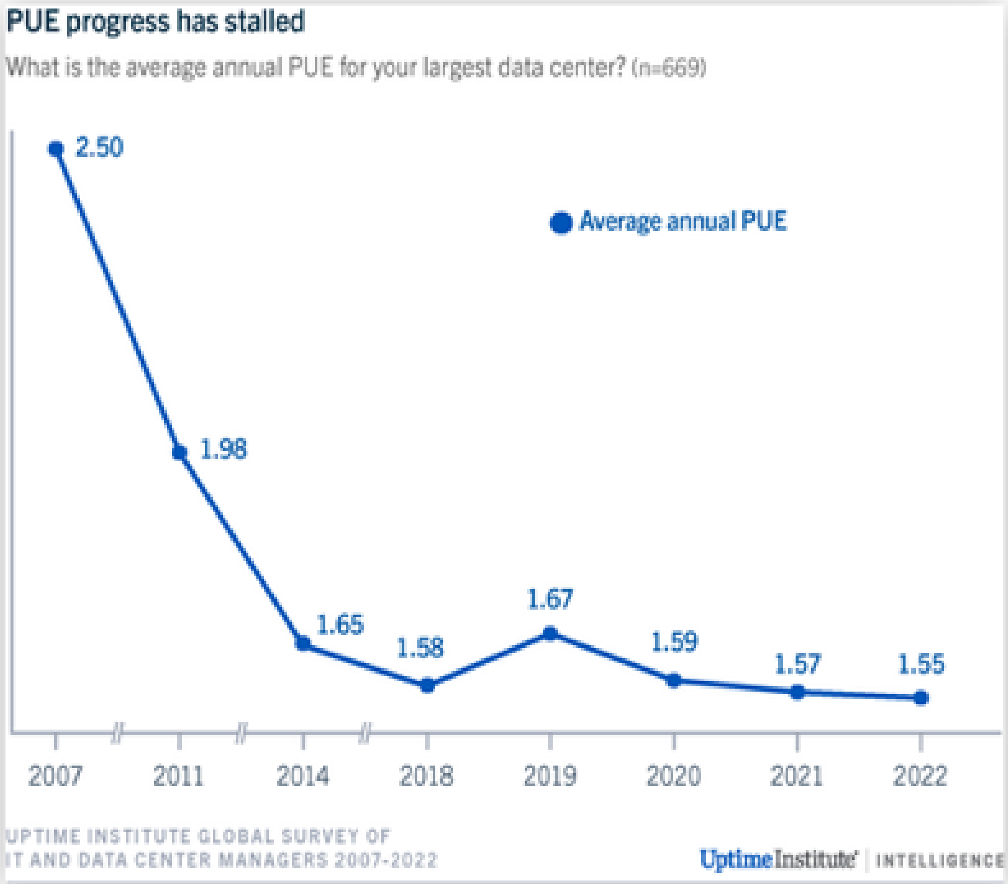
Between 2013 and 2022
Internet traffic grow at 40% per year (CGAR).
In the NW:
Data Center capacity grow at 20% (CAGR).
Revenue of data center entities grow at 23%   (CAGR)

NW Regional	2014	2022
Colocation Count	70	104
Colocation aMW	226	525
Hyperscale DC Count	8	8
Hyperscale DC aMW	249	500

Although demand for DC services has grown exponentially, power demand in DCs has not, in part due to Efficiency Gains



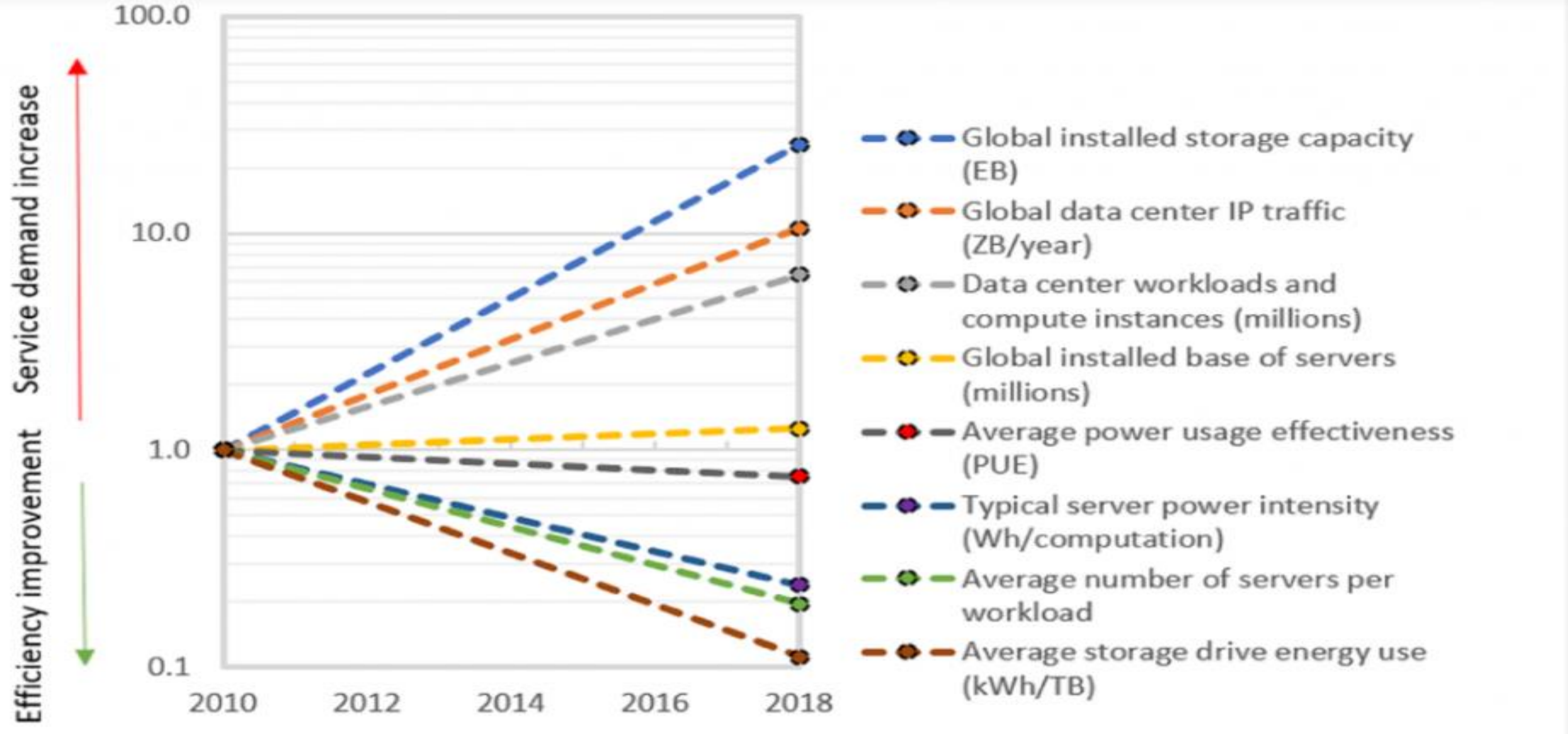
Typically 43% of Electricity used in a data center, is for servers, 11% for Storage drivers, 3% for networks Cooling and power provision systems use 43%. * 2016



Source: CISCO Global Internet reports

DC industry has been able to meet the demand for services

Trends in Global Data Center Energy Use and Efficiency Gains



…ure 3. Relative change in global data center energy use drivers (2010=1). Source: Masanet et al. 2020.

Future Trends and Constrains that will Impact the forecast

Growth and Trends in Demand

- Artificial Intelligence (AI)
- Internet Of Things (IOT)
- Edge Computing
- Crypto mining (not included in this forecast)
- Quantum Computing applications
- Future of Work-from-Home

Trends in supply

- Energy Efficiency (Koomy's and Moore's laws)
- Renewable Purchase Power Agreements
- Behind the meter renewable generation
- Automation using AI tools to predict and make suggestions for improving efficiency.
- Designing new buildings to meet LEED certification standards.
- Containerized/modular data centers
- Construction cycles of 4-5 years.

Constrains

Power supply and transmission availability may constrain pace of development of large data centers.

Two heroic Methodologies to Forecast Long-term Demand for Large Data Center Power

Approach 1 (bottom up- DC Model):

An engineering approach, Stock adjustment model that uses:

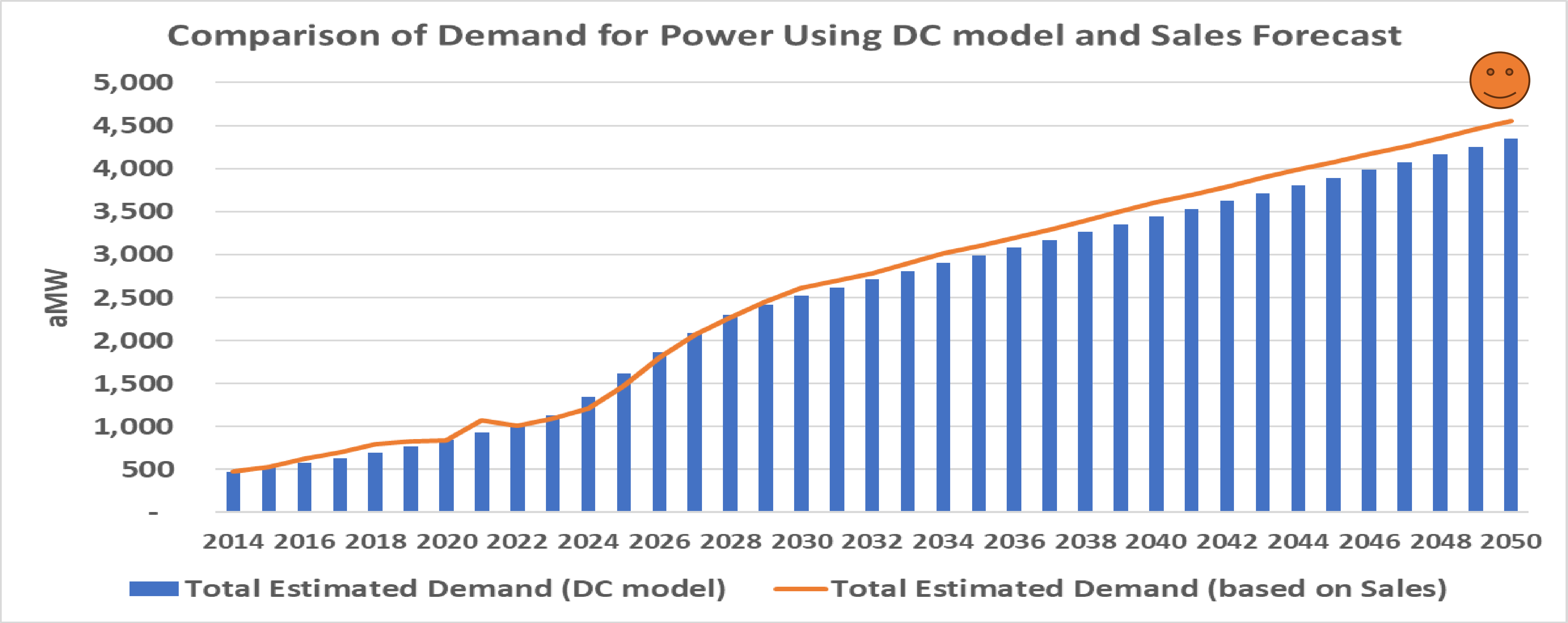
- Projections of web traffic,
- Counts, vintage, efficiency of DC components
- to estimates demand for power.
- Uses Moore's Law to project efficiency of servers.
- Uses Koomy's law to project power demand per calculation**.**

This approach requires more detail data on baseline efficiencies as well as projections on efficiency gains for servers, storage, and network. updating this information would require significant time and resources.

Approach 2 (top-down Sales Model):

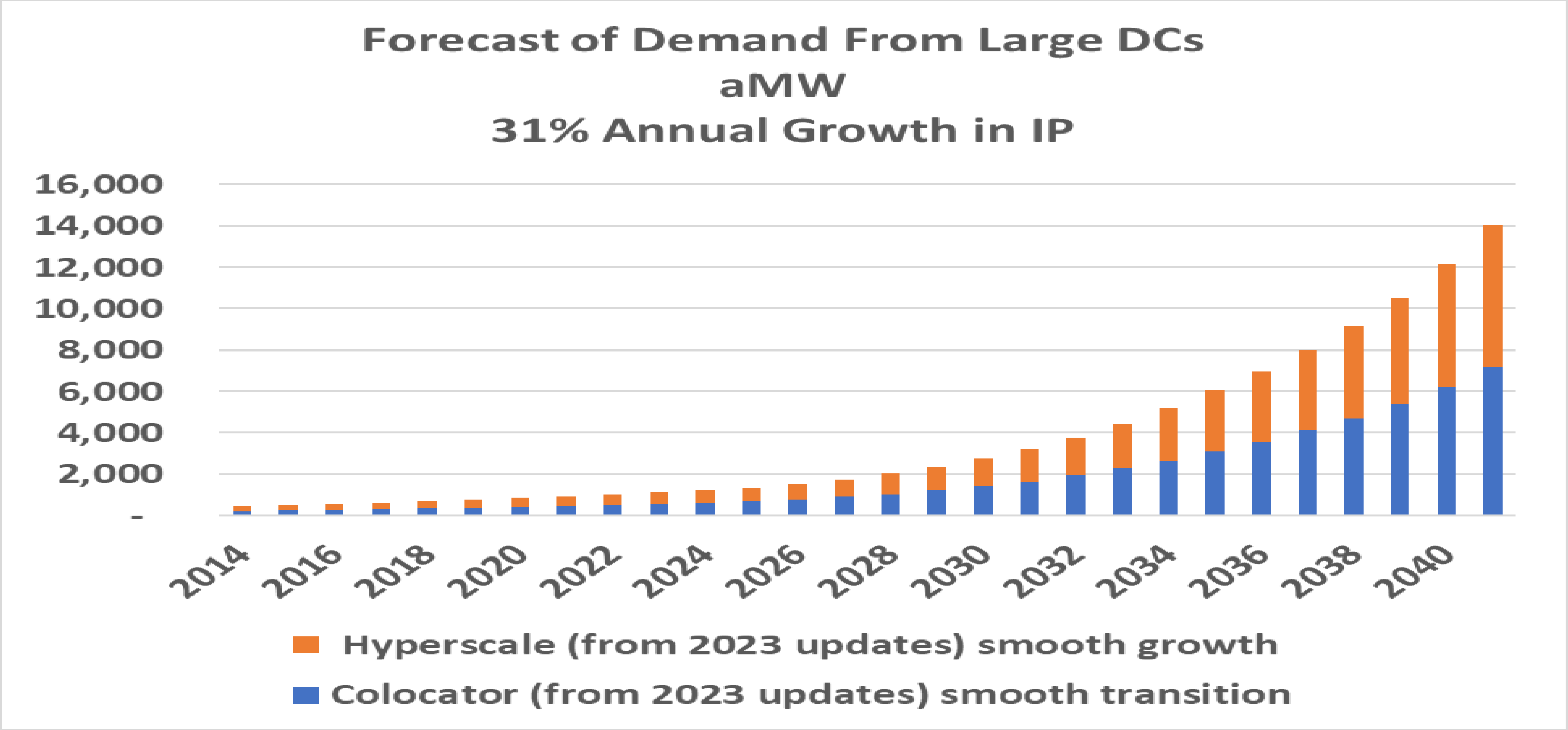
- It uses economic relationships between DC Sales/revenues, IP traffic and DC Capacity
- DC Sales and IP traffic are correlated strongly.
- Sales forecast was used as a rough proxy for IP forecast
- Forecast of DC capacity was estimated using Sales traffic.
- Forecasted growth rate in Sales was applied to existing DC capacity to project future DC capacity.
- This approach was simpler and more consistent with the economic growth trajectory for the region.

Comparison of the two approach indicate that two approaches Produce *Reasonably Close Forecasts*



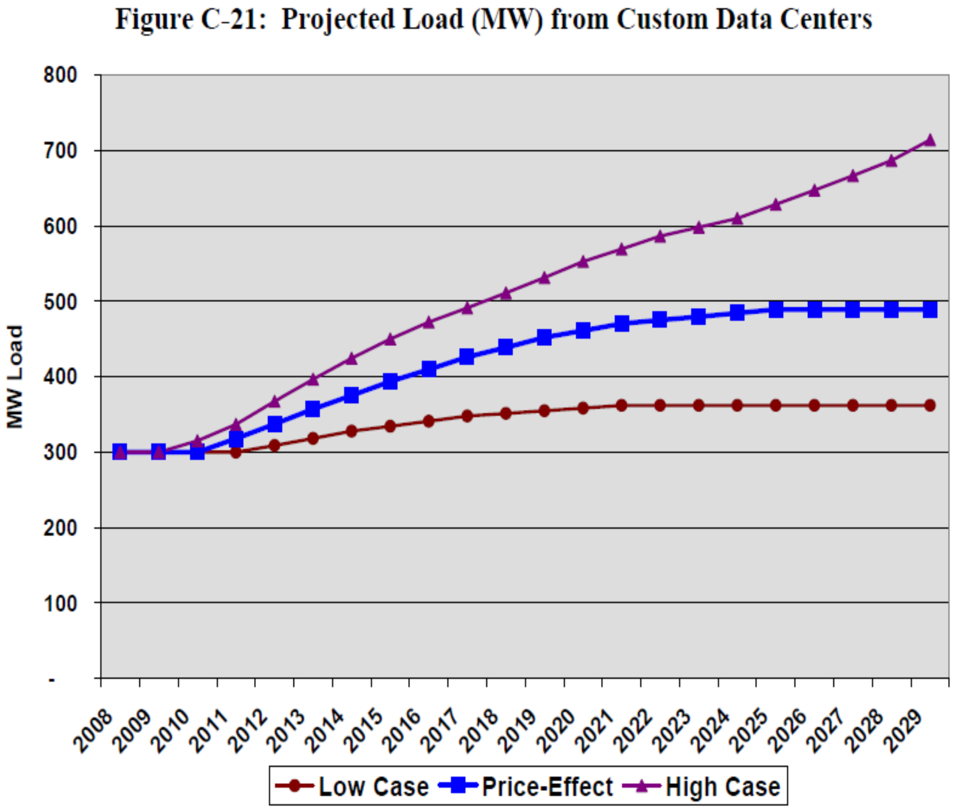
As a sensitivity we tested a “What if” analysis

If server workloads continue to grow at the recent rates, ~ 31%
The demand for power would be tremendous – possibly representing over 50% regional Load

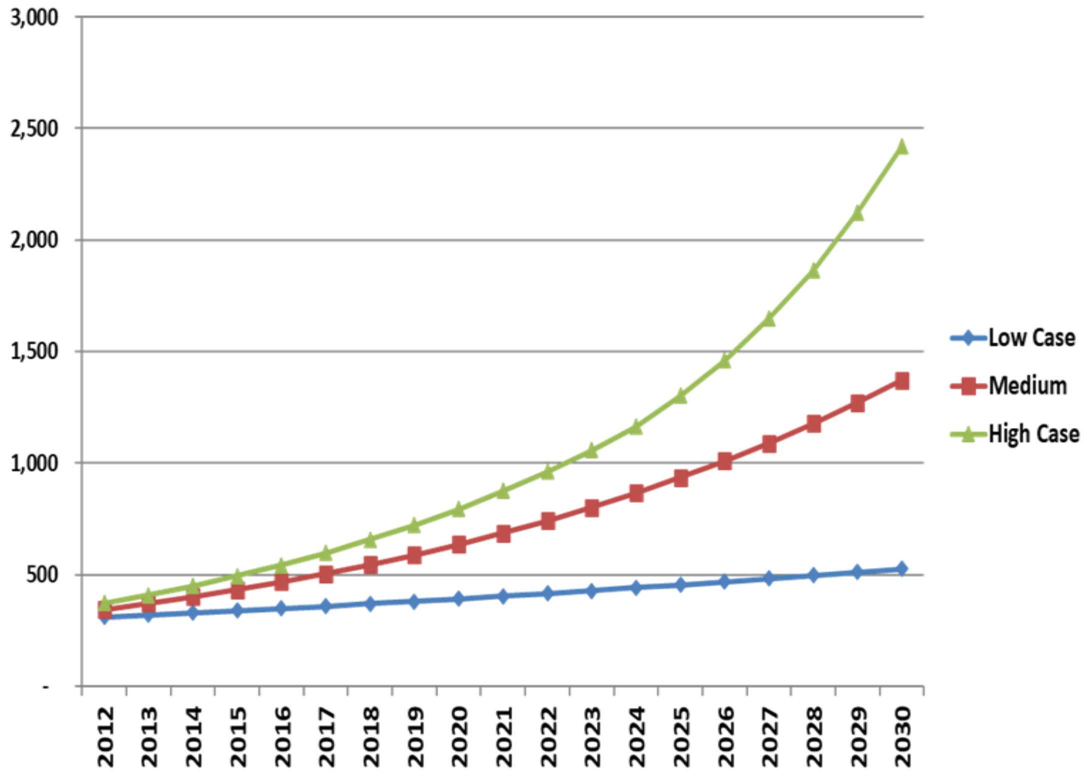


How well we had forecasted DC loads?
Under-estimating

Range of Forecast from 12 years ago



Range of Same Forecast Without Efficiency Improvements



Summary

- Nationally Growth in demand for data center services as been growing exponentially.
- Nationwide, data centers have increased their demand for electricity, however, gains in efficiency in the overall economy has kept demand for electricity flat.
- In the Northwest power to meet this demand has been growing but at about half the rate.
- Long-term forecast of demand for power is a heroic act, given rate of change in demand for services.
- The challenge facing utilities and data center owners is having the needed power in the right place and right time.

Questions

For Additional Information please reach out to

Mjourabchi@GreenwayResearchGroup.com

Drivers and Trends for Data Center Usage

- **Growth in demand for online E-commerce and streaming services**
- **Projected growth in Artificial Intelligence and Quantum computing**
- **Shift from closet servers to cloud/hyperscale**
- **Growth in connected Vehicles**
- **Growth in video streaming**
- **Appliance Connectivity, IOT**

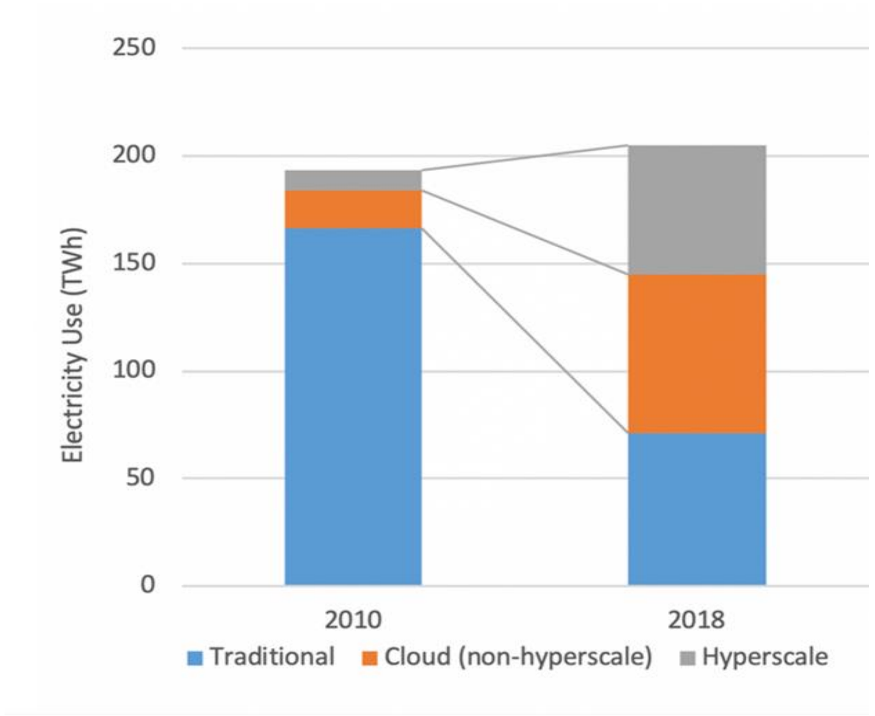


Figure 2. Estimated global data electricity use by data center type, 2010 and 2018. Source: Masanet et al. 2020.