City of Santa Clara
The Center of What's Possible

CITY OF SANTA CLARA
WORKING DRAFT WHITE PAPER
ON DATA CENTERS
PREPARED FOR JOINT PLANNING COMMISSION & CITY COUNCIL STUDY SESSION
MAY 20, 2025

WORKING DRAFT

TABLE OF CONTENTS

INTRODUCTION

The City of Santa Clara is in a unique position in Silicon Valley, as it has the most number of data centers in California with a total 56 active or under construction. As the number of data centers are growing, residents, Planning Commission and City Council members are also asking how data centers are evolving, challenges of energy capacity and usage, development of future data centers, land use development standards and aesthetics. This White Paper provides the framework for discussion for the May 20, 2025 joint study session on data centers with Planning Commission and City Council. The White Paper provides baseline data on the industry as a whole, nation-wide trends, and provides information on concerns raised that are beyond land use.

The White Paper begins by describing the growth of the industry and why it has evolved, the types of data centers, the market, energy sources with areas of efficiency that the industry is trending, broad economic data and finally challenges. In order to develop this White Paper, staff reached out to several established sources including recent industry articles, data center developers, and the Data Center Coalition, a national professional industry based out of Washington D.C., other cities including Loudoun County Virginia, home of the largest number of data centers in the U.S. Additional cities were researched and is provided in the report to council.

Earlier this year at the March 19, 2025 Planning Commission (PC) meeting, the Commission raised broader discussion topics and requested staff to provide the research on wider issues beyond land use. Some of the concerns raised were specific to the existing energy grid and what can be sustained with data center growth, alternative energy, efficient cooling, mandating green data centers, long term policies around active land uses, development standards with noise and heat generation, thermal energy, nuclear energy to power data centers, speculative land banking, security of data centers, aesthetics of data centers, rate we are charging data centers vs. residents, jobs created by data centers. The areas which are Silicon Valley Power (SVP) are covered in the power point presentation, while the broader issues are covered in this document. This White Paper is not a

market or economic analysis. Its intent is to provide high level insight into the data center industry and challenges that exist today. In addition to providing baseline data, the report incorporates the observations of key stakeholders on the emerging industry. The overarching goal of the White Paper is to provide staff, Planning Commissioners and City Council with resources and information to frame a discussion on data centers. This white paper is intended to address an overview of the industry trends, data and information from the industry in the US.

OVERVIEW OF THE INDUSTRY

On a national scale, data centers are relied on as an essential infrastructure, and the industry has seen significant growth with AI in sectors such as governments, businesses, medicine and households adopting digital transformation. Data centers support the growth of the digital economy, including e-commerce, storage of data, social media, all digital technologies including products such as software and phones, government, telecommunications, data collection, data storage, e-business and more. The U.S. accounts for about 40% of the global data center market, followed by Europe, Latin America and Asia-Pacific. Chart 1 illustrates by megawatt, a global data center market, and demonstrates Northern Virginia as the largest data center characterized by megawatts. Northern Virginia remains the world's largest data center market with 2,132 megawatts (MW) of total inventory[1], with a projected 19.5% increase from 2022 to 2023. Other large U.S. markets include Dallas/Fort Worth, Silicon Valley, Chicago, Phoenix, Atlanta, Hillsboro, New York tri-state area, see Chart 2 for total primary market percentages.

The data center industry is experiencing rapid growth due to several factors, including the increasing adoption of digital technologies, particularly artificial intelligence (AI), cloud computing, and big data analytics, all of which require vast amounts of data storage and processing power. This growth is also fueled by the outsourcing of data management to specialized providers and the demand for higher density and efficiency in data center design. A large contributing factor in the rise of the industry is that many business sectors during the pandemic switched to more digital services for their operations. In the Northern California data center market, Silicon Valley/Santa Clara experienced a vacancy rate of 1.6%, making it one of the tightest data center markets in the US according to CBRE[2]. AI and machine learning models require massive amounts of data and processing power, which leads to a surge in demand for data centers that can handle these computational needs.

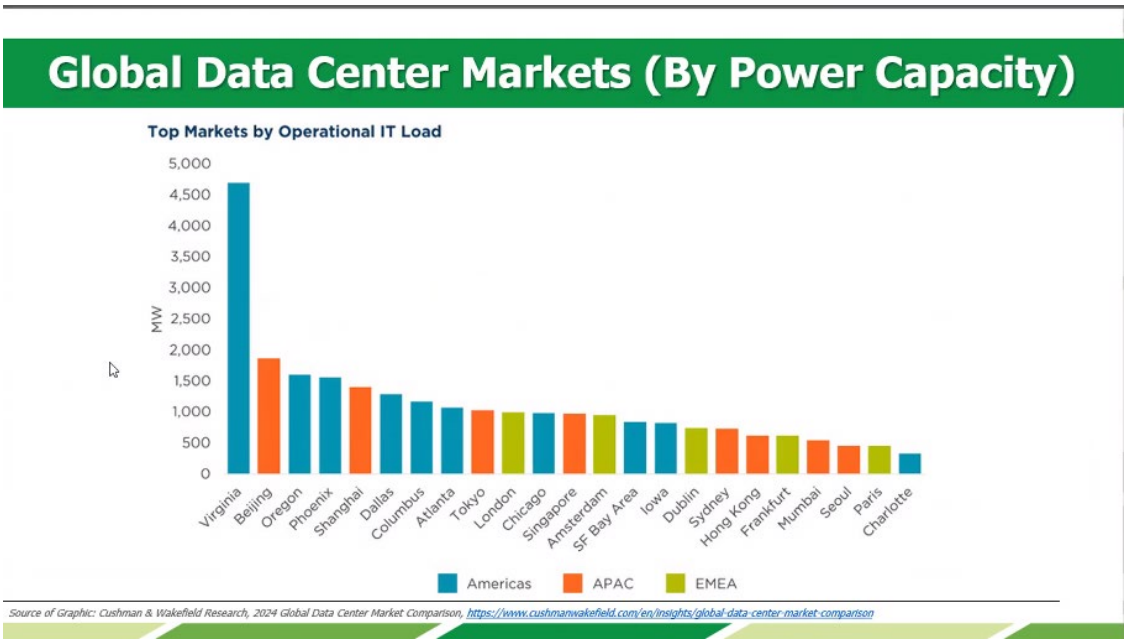

Chart 1, Source: Cushman & Wakefield Research, 2024 Global Data Center Market Comparison

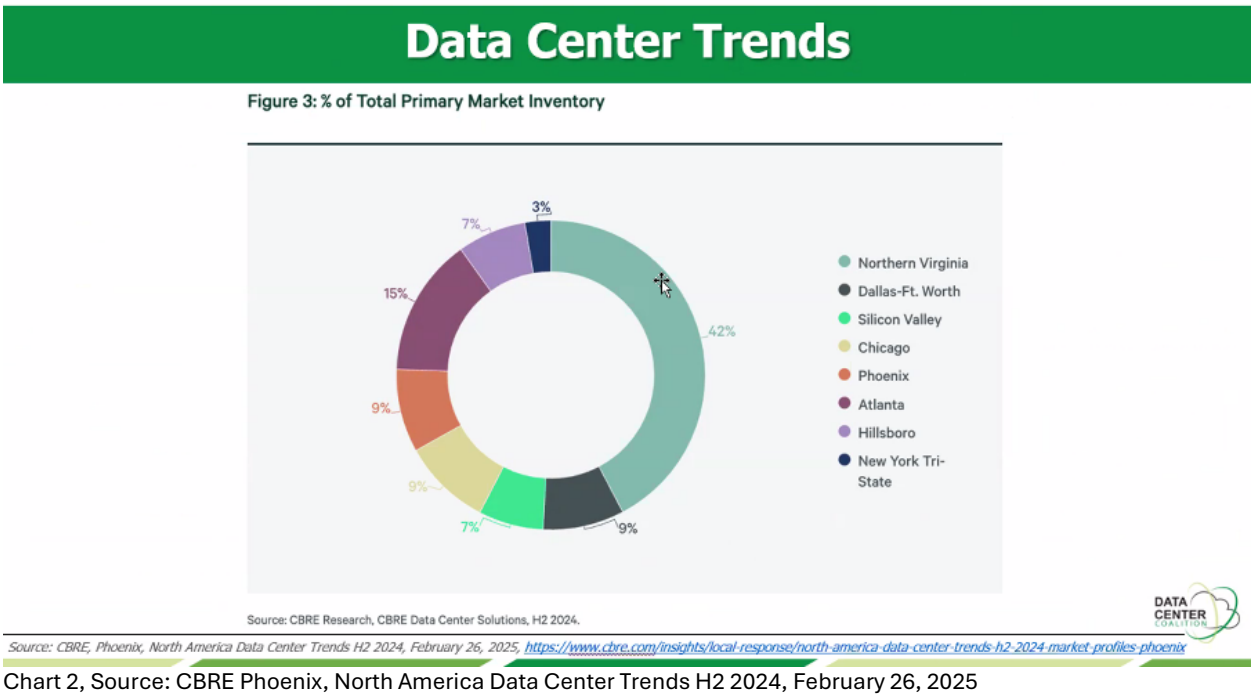

Chart 2, Source: CBRE Phoenix, North America Data Center Trends H2 2024, February 26, 2025

The increasing reliance on cloud services, which are hosted in data centers, drives significant increase in data center demand. The rapid growth of the internet and increasing amount of data generated by individuals, businesses, and devices have created a need for larger and more efficient data centers. The rapid growth of artificial intelligence—along with other modern technologies, such as streaming, gaming and self-driving cars—is expected to drive continued strong data center demand. A Senior Director with U.S. Government Affairs with Microsoft explained that every business operation is now reliant on cloud technology, every operation is running on cloud and large percentage is cloud enabled including the 5G network. Without data centers all cellular phones will

be impaired. Hospitals and even public safety are all cloud reliant. AI is the next extension of cloud technology. The average number of cloud technologies per household is 21—thermostat, fitness tracker, phone, and appliances using these services, see Chart 3. Bay Area is home to cloud technology, with major companies such as Cisco, Adobe, Microsoft, Google, Zoom and even traditional businesses rely on cloud technology, in other words data centers should be viewed the same as electricity or transportation. Several developers shared that limiting or saying no to data centers is catastrophic for business development and Silicon Valley's growth.

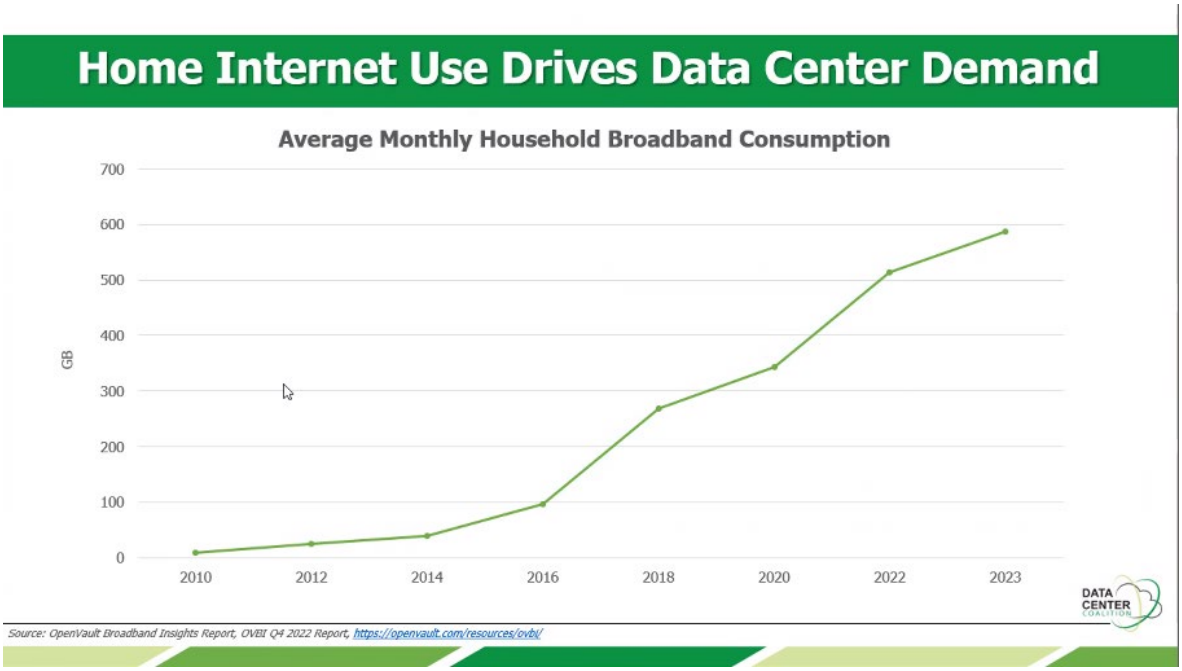

Chart 3, Source: Data Center Coalition Open Vault Broadband Insights Report, Q4 2022 Report

DATA CENTER MARKETS & TYPES

The primary U.S. data center markets are Northern Virginia, Northern California, Dallas, Atlanta and Chicago. New developments are being rapidly pre-leased, with datacenter Hawk reporting that more than 1.4GW of the 1.5GW absorbed in Northern Virginia in 2024 was pre-leased. Across the country, it is estimated by Colliers [3] at least 70% of new product is pre-leased, contributing to a national average vacancy rate of just 2%. According to Goldman Sachs, data center power demand is projected to grow by at least 160% by 2030, primarily driven by AI workloads. The Northern Virginia market is characterized by larger more horizontal footprints due to land availability with 200,000 to 250,000 square feet as typical size, while the Northern California market is more vertical due to limited land. Digital Realty a developer of multiple data centers in Santa Clara shared there is a preference to develop data centers near each other as they operate as a block. Due to future anticipated site constraints, data centers will likely develop as three-story buildings in more land constricted Bay Area.

Loudoun County Virginia is one of the first established markets for data centers due to the historic cross Atlantic lines to Europe and Africa, link to Department of Defense for research and universities that required more traditional data storage. The area continued to evolve over decades with the first network access in 1997, America Online or AOL, fiber-optic cable and energy infrastructure. Virginia was one of handful of states that continued to attract data centers dues to 2009 tax exemption.

Loudoun County staff shared that due to multiple economic benefits the County is favorable with financial and tax benefits, clustering of infrastructure and favorable zoning. A major boost to the economy, data centers bring in increased property taxes, and in Northern Virginia with 2.3 billion in revenue.

As power availability in primary markets becomes limited, new markets are emerging, such as Phoenix, Minneapolis, and Reno that embrace the development and are attractive due to proximity to primary markets. Secondary and tertiary markets are drawing increased interest despite the significant capital investments required in these markets. In Vernon, just southeast of Los Angeles, developers have found a viable alternative to the already power-constrained Los Angeles market. The area's available low-cost power and favorable zoning have attracted Prime Data Centers, CoreSite, and Goodman to buy land for data center developments. The land is coupled with availability of more readily available power. Digital Realty shared that markets in Sacramento and Portland are being explored due to power availability and a push back from the more urban markets initially developed in. Environmental and public comments are becoming more of an issue in the earlier urban markets where data centers first emerged.

Silicon Valley and specifically Santa Clara is the largest market for data centers in California, with Microsoft being the largest data center operator in Santa Clara. Santa Clara is an attractive market due to Silicon Valley Power (SVP) competitive rates, a favorable development market, certainty of development review, and importantly reduced latency with proximity to customers. Key siting considerations for data centers include:

- Access to Fiber/Interconnection
- Access to Water for Industrial Purposes
- Access to Clean, Reliable, Affordable Energy
- Climate and Risk of Natural Disaster
- Land Availability and Cost
- Tax and Regulatory Climate
- Ownership/Occupancy Costs
- Time to Market
- Access to Skilled Construction and Technology Workforce

Colocation of data centers allows for information to process faster, because that is where bulk of people live, and faster access to information is key. The further away from storage the more time it will take to get the information. In Santa Clara, in 2024, NVIDIA's market valuation skyrocketed past $3 trillion, due to dominance in producing data center chips. Nvidia's Enterprise AI Survey reported a 42% increase in global usage of NVIDIA GPU-powered systems, which now supports more than 45,000 enterprise AI projects worldwide according to Colliers [4]. Microsoft provided that the current vacancy in California is 2.5% which is a similar rate shared by other developers as well.

Data centers require significant investment, with Menlo Equities sharing that a recent 950,000 square foot Data Center cost $1.5 billion dollars to build, while the interior AI racks and equipment cost three times more that the exterior shell of the building. Blackstone projects up to $2 trillion in generative AI investment in the sector over the next five years, with half of that spending concentrated in the U.S. Additionally, vacant industrial office parks and buildings are also being replaced by data centers, as data centers attract more high-paying jobs.

Types of Data Centers
Data center size, height and location is dependent on the user type and scale that they serve. There are five types of data centers, and they vary according to use and need.

Hyperscale Data Centers are characterized by their enormous size, processing power, and storage capacity, often housing thousands of servers and requiring vast amounts of space and power. These facilities are built to handle the demands of large-scale, data-intensive applications, such as cloud computing, big data analytics, and AI model training. Hyperscale facilities are designed for dedicated, high-capacity deployments, often with a focus on efficiency and scalability. Major companies like Amazon, Google, Microsoft and Meta are known for their large-scale data needs, and often rely on hyperscale data centers to power their services. Hyperscale facilities are typically not in a single building. Instead, they operate as a distributed network of interconnected sites. Virginia hosts the highest electricity demand associated with data centers in the United States, serving as the primary hub for both colocation and hyperscale data centers, followed by California and Texas. A hyperscale facility consists of:

- Has at least 10,000 sq. ft. of space across one or more buildings.
- Houses at least 5,000 dedicated servers.
- Consumes over 50 megawatts (MW) of energy annually, enough to power roughly 35,000 U.S. homes.
- Many hyperscale centers need dedicated power stations to meet their energy demands.

Multi-Tenant/Colocation data centers offer flexibility and shared resources, where an organization can lease the amount of space they need to host their data and, as their needs change, they can quickly scale up or down. All types of industries take advantage of multi-tenant data centers, from healthcare and banking to manufacturing and government agencies. Many of the developer's staff outreached to for this paper did multi-tenant construction and then leased space or racks to various technology companies. The developers will also manage the buildings once constructed and provide services such as security and maintenance.

Enterprise Data Centers are often more customized to meet specific organizational needs, resulting in less modularity and scalability. An enterprise data center is owned and operated by a single organization, such as finance, healthcare, or government. It serves to house the organization's internal IT infrastructure.

Edge/Micro Data Centers are small and located near the people they serve to handle real-time data processing, analysis and action, making low-latency communication with smart devices possible.

Container/Modular Data Center is usually a module or shipping container that's packaged with ready-made, plug-and-play data center components: servers, storage, networking gear, UPS, generators, air conditioners, etc. Modular types now being used in temporary and permanent deployments. Modular data centers are typically used on construction sites or in disaster areas.

Energy Sources & Impacts
This section of the report discusses energy consumption trends, primary and secondary sources of energy and in general where the industry is going with energy demands. For this section of the report, staff relied primarily on a paper developed by Berkeley Lab Energy Analysis & Environmental Impacts

Division. The Berkeley Lab report was developed to meet a Congressional request on data centers nationwide, which estimates historical data center electricity consumption dating back to 2014, and future demand out to 2028 based on new trends and recent available data in the Berkeley Lab report.[5] The consumption of energy for a data center includes many overall factors including infrastructure electricity and water, building operations with IT equipment electricity demand and racks for servers. Data center energy consumption is measured in megawatts. A megawatt (MW) is a unit of power, equivalent to one million watts or one thousand kilowatts. It represents the rate at which energy is being delivered or used. As an example, one megawatt is enough to power 1,000 average homes. The largest datacenters, called hyperscale data center may use over 100 MW, as an example in Chicago a 700,000 square foot data center required 198 MW of power.

Overall, the report indicates that between 2010-2016, the trend was minimal growth in annual energy use for data centers, in 2017, the overall trend shifted with the rise in Graphic Processing Unit (GPU) accelerated servers for AI by 2018 with 1.9%, and a greater energy increase in 2023 by 4.4% of U.S. energy consumption. It is forecasted that energy consumption by 2028 will be between a range of 6.7% to 12.0%. The graphic below provided by Berkeley Labs shows energy consumption of data centers since 2014 and the future projected increased demand to 2028.

With the rise of energy consumption, there are efficiency improvements by the industry to decrease energy needs, improved cooling and power management, increased server utilization rates, increased computational efficiencies, and reduced server idle power. With the energy demand forecasted, the data center industry is identifying new efficiency strategies to minimize the resource impacts. The Data Center Coalition provided that while energy consumption by data centers rose by six percent from 2010 to 2018, computing output jumped 550%.

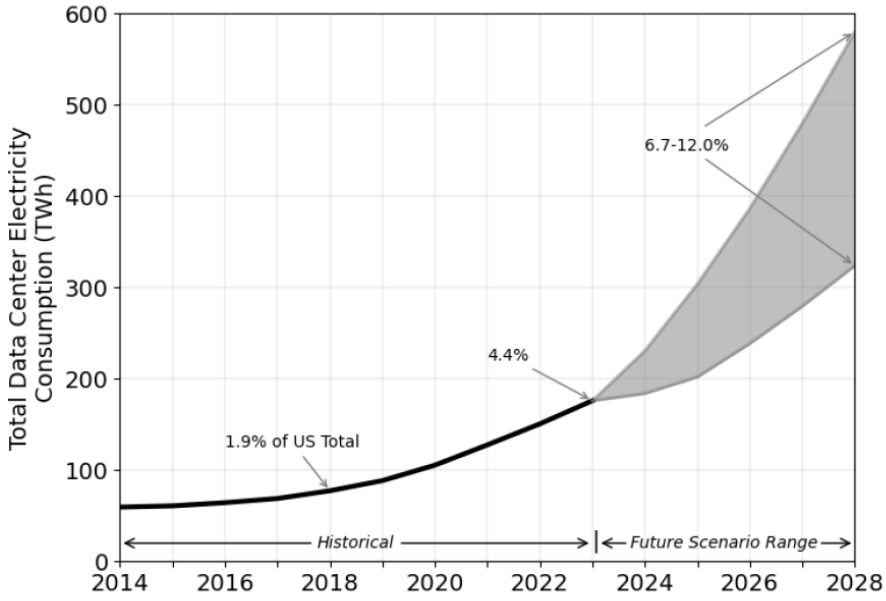

Figure ES-1. Total U.S. data center electricity use from 2014 through 2028.

Chart 4, Source: Berkeley Lab Energy Analysis & Environmental Impacts Division 2024 United States Data Center Energy Usage Report

Data center investors and operators are turning to renewable energy sources like solar, wind, and hydro for power shortages, however the grid remains the primary reliable source of energy. Despite the energy demand, other cities are actively recruiting data centers such as San Jose. In November 2024, San Jose partnered with Westbank real estate developer to approve three new data centers with 200 MW to bring approximately 3.8 to 6.5 million property and utility taxes according to Data Center Construction Channel[6]. Pacific Gas & Electric (PG&E) recognizes energy usage is 24/7 with a strong return on investment, so PG&E is building a power plant to supply the higher load and take in the strong revenue.

Cooling Systems

Gensler is engineering data centers with greater power densities per square foot, allowing for energy-efficient technologies, like immersion cooling. This helps the building footprint to shrink and thereby become more energy efficient[7]. The Berkeley Labs report evaluated nine cooling systems commonly implemented in the U.S. for data centers analyzed by Power Usage Effectiveness (PUE) and water consumption (WUE). The PUE and WUE metrics of data centers are influenced by various factors, including cooling systems, operational practices, and climatic conditions. The overall trend is a shift to more energy efficient hyperscale and colocation facilities, combined with an increase in liquid-cooled AI servers. Moreover, in IT liquid-cooled data centers, WUE values can be further reduced through improved heat transfer and elevated coolant/facility water temperature throughout the year. A Senior Director for U.S. Government Affairs with Microsoft provided that water needs to be taken into account and the industry is using closed loop systems instead of evaporating—where water is filled just once. The industry is evolving, and the building is engineered around cooling systems and racks for less water usage. Digital Realty is developing buildings with grey water and economizing with outside air. Similarly, Microsoft data center buildings are using a closed loop system which relies on less water. Due the amount of water usage, developers consider the usage and get a will serve letter from the local utility. Data Center Coalition shared initiatives are being advanced with liquid cooling where a chip is submerged directly into a cooling liquid. Chip technology is also evolving to withstand higher temperatures.

Renewable Energy

Renewable energy has become a critical factor in site selection as hyperscalers evaluate long-term sustainability and power availability. All major data center sectors have entered into renewable energy agreements, such as Microsoft's partnership with Brookfield to develop over 10.5GW of renewable energy capacity by 2030. Meta has committed to almost 1 GW of solar power across Ohio, Texas, New Mexico, and Arkansas. Apple is developing solar projects across Michigan to bring 132 MW of clean energy online in 2025. However, even with alternative energy sources, according to a Menlo Equities, the power grid is the primary source of energy and alternative energy such as fuel cells augment the power grid. Data centers rely on so much power and consistent power, they want secure power with 100% back up for at least 48 hours. As an example, 100 MW data center relies on more than 100 MW of energy. It was shared that NRGY, has a power generating plant, but wind and solar is not 100% reliable and a data center cannot run only on fuel cells alone. In Sunnyvale a new data center has a high-capacity gas line and substation using turbine energy to augment. According to the Microsoft Senior Director, the industry likes redundancy, with the grid is the most reliable primary power. Diesel or natural gas is not discussed due to single point failure. The industry is driven by cost and is looking at opportunities for more environmental solutions to reduce building operations costs.

With the projected growth of data centers' energy use in the coming years, indirect water consumption and emissions are also expected to increase. Decarbonization of the power sector is a critical requirement to achieving net-zero GHG emissions goal and transitioning to newer generation technologies like renewable energy. The data center industry has shown interest and leadership in implementing real-time renewable energy and zero carbon power, including battery storage resources. Future research efforts will include working with utilities and data center companies to develop strategies for renewable energy projects and new clean power.

Dominion Energy in Northern Virginia revealed that current power availability issues are reflective of transmission and distribution issues, not power generation. The Northern Virginia region has approximately 34% of power supply for electricity tied to nuclear plants. In California, the market is more regulated, a data center will go through environmental review through the California Environmental Quality Act (CEQA) and a project must have no significant environmental impact and is therefore a very rigorous process. To get a small power plant approval you must go through California Energy Commission (CEC) and conform to water air regulations and environmental review. In addition to State regulations, local permitting processes require a will serve letter from all utilities. Due to a heavily regulated California environment, data centers are typically required to conform with water and air quality with the cleanest Tier 4 standards in the industry. Currently, diesel generators are only used as backup technology and for periodic testing to ensure function.

In researching nuclear energy in California tied to data centers, staff could not find any direct sources to support data centers with nuclear energy. Staff discussed the future possibility with developers, and the current market does not support nuclear energy due to associated or perceived risks. Microsoft shared small reactors have not worked out because the technology is not ready.

Security

Due to the nature of data center storage of information, they are designed with high security. The buildings are highly secured with no customers and only required staff allowed. Security at the buildings is 24-hour on site with multiple layers as security is paramount. Physical access is usually restricted with layered security consisting of fencing, bollards and mantraps. Video camera surveillance and permanent security guards are present if the data center is large or contains sensitive information. Fingerprint recognition mantraps are starting to be commonplace. Logging access is required by some data protection regulations; some organizations tightly link this to access control systems. Multiple log entries can occur at the main entrance, entrances to internal rooms, and at equipment cabinets. Access control at cabinets can be integrated with intelligent power distribution units, so that locks are networked through the same appliance
Data Center Coalition shared that due to high security even staff from the Coalition is not allowed in server rooms of the building.

Microsoft Senior Director provided there are additional security features for servers of the buildings which include 99.99% uptime guaranteed with redundancy at every step with two connections to the grid, and every facility has back up batteries for short interruptions. The back up generation always has grid reliability with 0.1% back up.

Economic Impacts

Concerns regarding data centers have been raised as to job creation, employment and after construction on-site activity. The concern articulated is from both an economic and land use perspective in that once a data center is built it is not an employment center like an office nor an

active use like retail. This section of the report evaluates the economic trends and how the shifting market is impacting the land use. Staff reached out to the developers and the Data Center Coalition to understand the impact of the industry in terms of jobs and growth.

Menlo Equities shared data centers are the required infrastructure and backbone of the high-tech industry. Any growth in the tech sector requires data centers to be located in proximity. Artificial intelligence is a key focus for Fortune 500 companies, projected to significantly drive future demand. In Loudoun County Virginia, it is estimated data centers bring in 2.3 billion dollars in property tax revenue. The growth is expected to be exponential over the next number of years. The Data Center Coalition tracks the industry in terms of jobs nationwide and there is a 51% increase from 2017 in direct jobs, with 603,900 in 2023. Between 2017 and 2023 there was a 93% increase or $404 billion in total labor income. In terms of federal, state and local taxes, between 2017 and 2023 there was a $162.7 billion in total impact or 146% increase, see Chart 4 below.

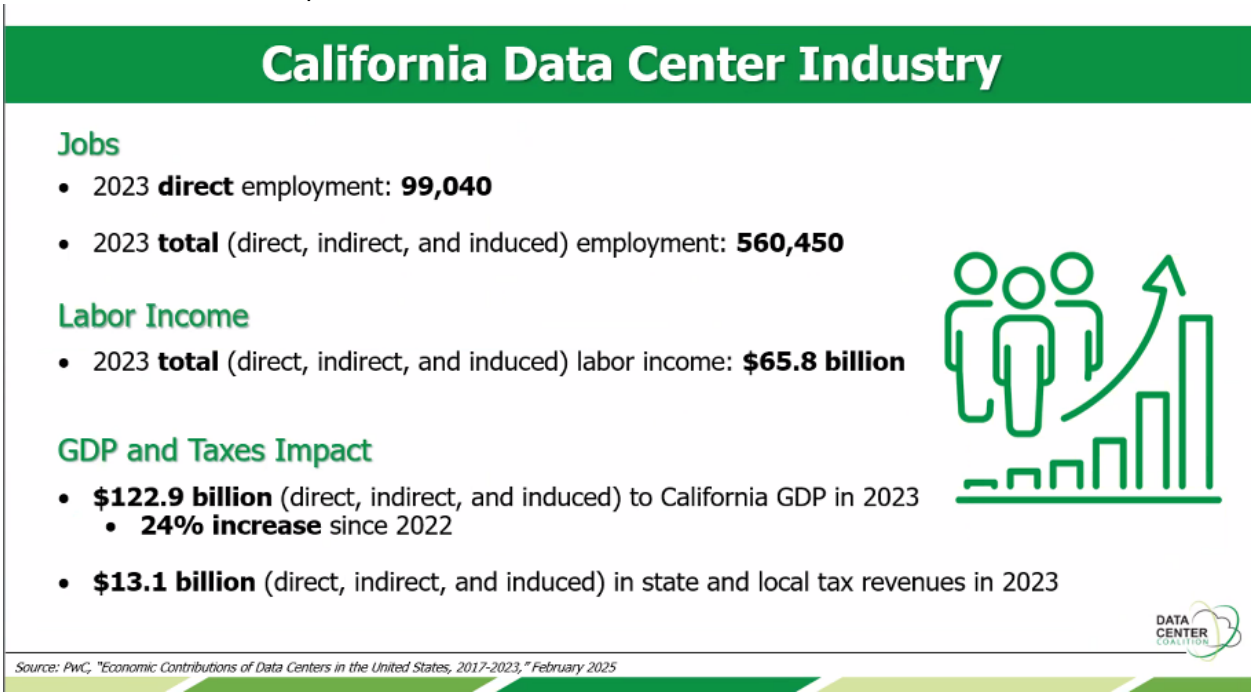

Chart 5, PwC Economic Contributions of Data Centers in the United Stated, 2017-2023, February 2025

Since Covid 19, the office and retail markets are trending downwards, while data centers in primary North American markets, have fallen to record low vacancy rates, with CBRE reporting a 1.9% vacancy rate in H2 2024. The industry is seeing a rise in construction; however, the market is struggling to keep up with demand. The national office vacancy rate reached 19.9% in March 2025, according to CommercialEdge[8], up from 19.6% in 2023. Factors like hybrid work models, remote work, and a shift in employee priorities have contributed to the increase in office vacancies. In summary, data centers are experiencing extremely low vacancy rates due to high demand, while office spaces are facing increased vacancy due to shifts in work patterns and economic uncertainty.

The economic opportunity for communities with data centers, may not lie in substantial jobs, but in is the high value improvements and equipment made inside of data center buildings. In California, these types of improvements are part of the assessed value of a property for property tax purposes. In addition, there is potential for high sales tax revenue on site. Communities like the City of Santa

Clara that have their own power utility, also have the ability to impose a utility tax, which benefits the municipality. In Santa Clara, 5% of utility tax revenue is transferred to the City's General Fund.

Challenges

With the rapid rise of the data center industry many developers and communities staff spoke to are facing similar challenges due to community push back and availability of power. The staff report articulates the challenges, however an overview from the broader discussion is provided below. The challenges are list below with a brief description.

Limited Power Capacity:

All developers provided limited power is an issue and this is accounted when investing in communities where power is a challenge or power is out for several years. Currently, there are not enough data centers due to power restrictions, and the demand will continue to rise. Other markets are being explored that have power availability. Many established markets are already at or near capacity, compelling tenants to prioritize power availability and scalability over traditional market preferences. Secondary and tertiary markets are drawing increased interest despite the significant capital investments required. However, the industry continues to face significant power challenges.

Entitlements:

Developers generally spoke in favor of the Santa Clara entitlement process. They cited a development friendly environment and certainty of review. Developers shared they liked the coordination with multiple staff from various departments and avoiding late hits. Developers shared that a more restrictive entitlement process would make other cities more desirable as timing of review makes an impact on the overall investment. It was shared that additional standards such as objective design standards or setbacks would be acceptable. One developer shared that because parking requirements on site a minimal, the remaining excess parking is being converted in other cities to landscape areas.

Aesthetics:

The City of Phoenix requires review by a land development committee if a data center is located adjacent to a residential district.

Loudoun County shared that with the concentration of data centers it does have an impact on land use and is seeing manufacturing and more employee intensive uses being replaced. The County did see enormous tax benefits. The County is now looking at a phased approach to the standards for data centers. Phase 1 now requires a Special Exception in certain Commercial and Office zones and within most Industrial zoning districts and if a data center is close to a residential district, then the County Board will have review and approval authority. The County is also evaluating the design of substations and the visual impact. Jurisdictions in Virginia have implemented minimum setback standards for parking, buildings, and mechanical equipment and substations for data centers located adjacent to residential developments as well as providing landscaping and natural buffers. Phase 2 will evaluate development standards such as noise, see below.

Gensler, an architectural firm, is doing a data center for Time Warner Cable for 50,000 sf of space and 6.4 MW. The firm is employing a curtain wall system and range of exterior materials to push the design envelope [9]. Gensler is incorporating data centers into campus plans such as Fermilab in Batavia, Illinois and into the early design of major labs and hospitals.

Menlo Equities shared that newer designs are incorporating more glass to emulate an office setting. The glass is applied to a pre-cast concrete design and gives the impression of an office building.

Image Source: Menlo Equities

Noise:

Louden County sees noise as a key issue to regulate as not all data center developers are using high-cost equipment. Noise is being evaluated as Phase 2 revisions to development standards. In Santa Clara, noise was a bigger issue during the pandemic, and with further noise studies and assessments it has become a non-issue.

ADD SUMMARY_"LAND THE PLANE"

REFERENCES

1 Global Data Center Trends June 24, 2024 2024 CBRE Research
2 CBRE North America Data Center Vacancy Rates August 20, 2024
3,4 Colliers U.S. Research Report 2025 Data Center Marketplace
5 Berkeley Lab Energy Analysis & Environmental Impacts Division 2024 United States Data Center Energy Usage Report
6 Data Center Construction Channel
7 Gensler Critical Facilities
8 CommercialEdge April 2025 Office Market Report
9 Gensler Charter Communications National Center West
10 The Reg-Silicon Valley Data Center Market
11 Costar-Colovore snaps up renovated data center facility in Silicon Valley
12 WSJ-Big Tech Is Rushing to Find Clean Power to Fuel AIs Insatiable Appetite
13 Costar Tariffs threaten to push data center project costs higher