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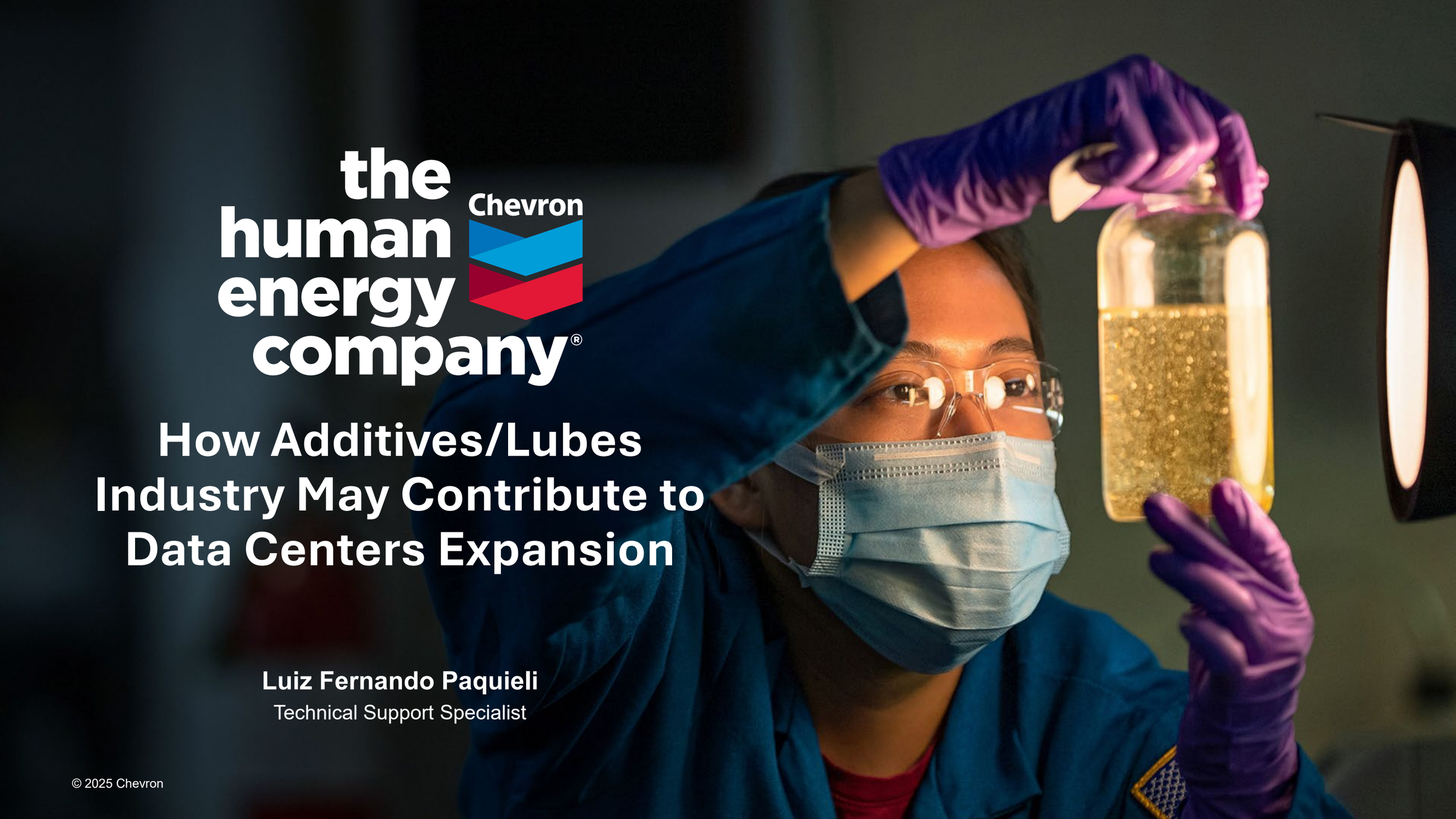
How Additives/Lubes Industry May Contribute to Data Centers Expansion

Luiz Fernando Paquieli
Technical Support Specialist

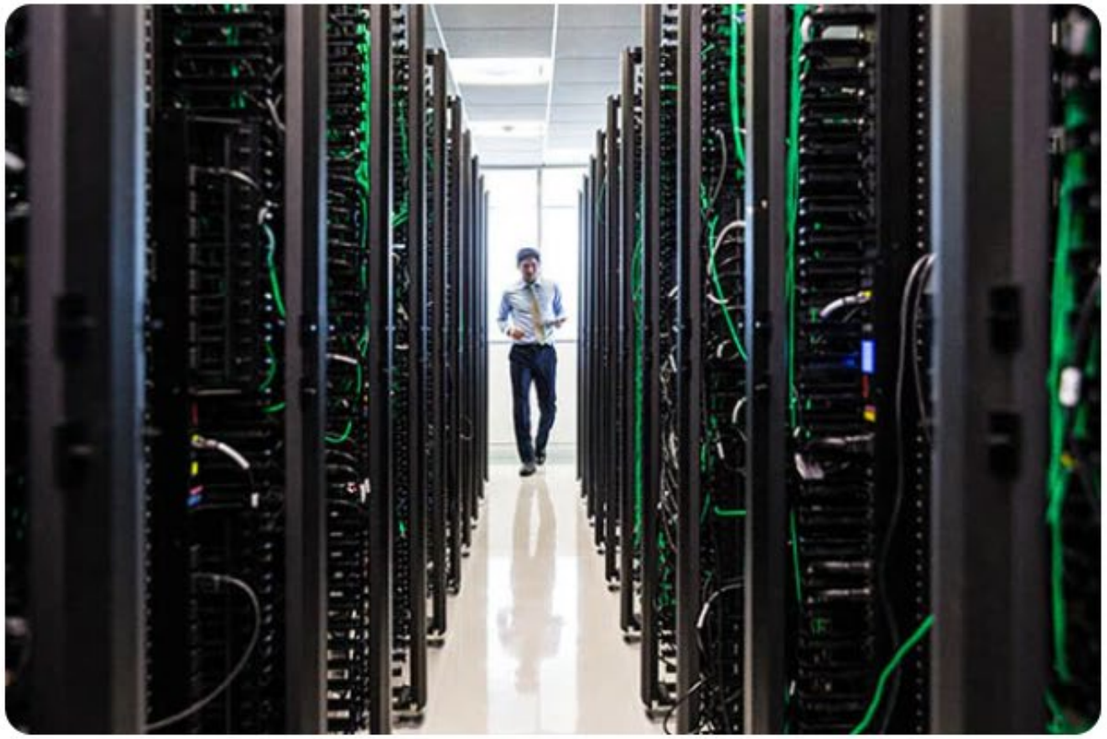


The New York Times

How the Internet Travels Across Oceans - The New York Times

Data Centers - Introduction

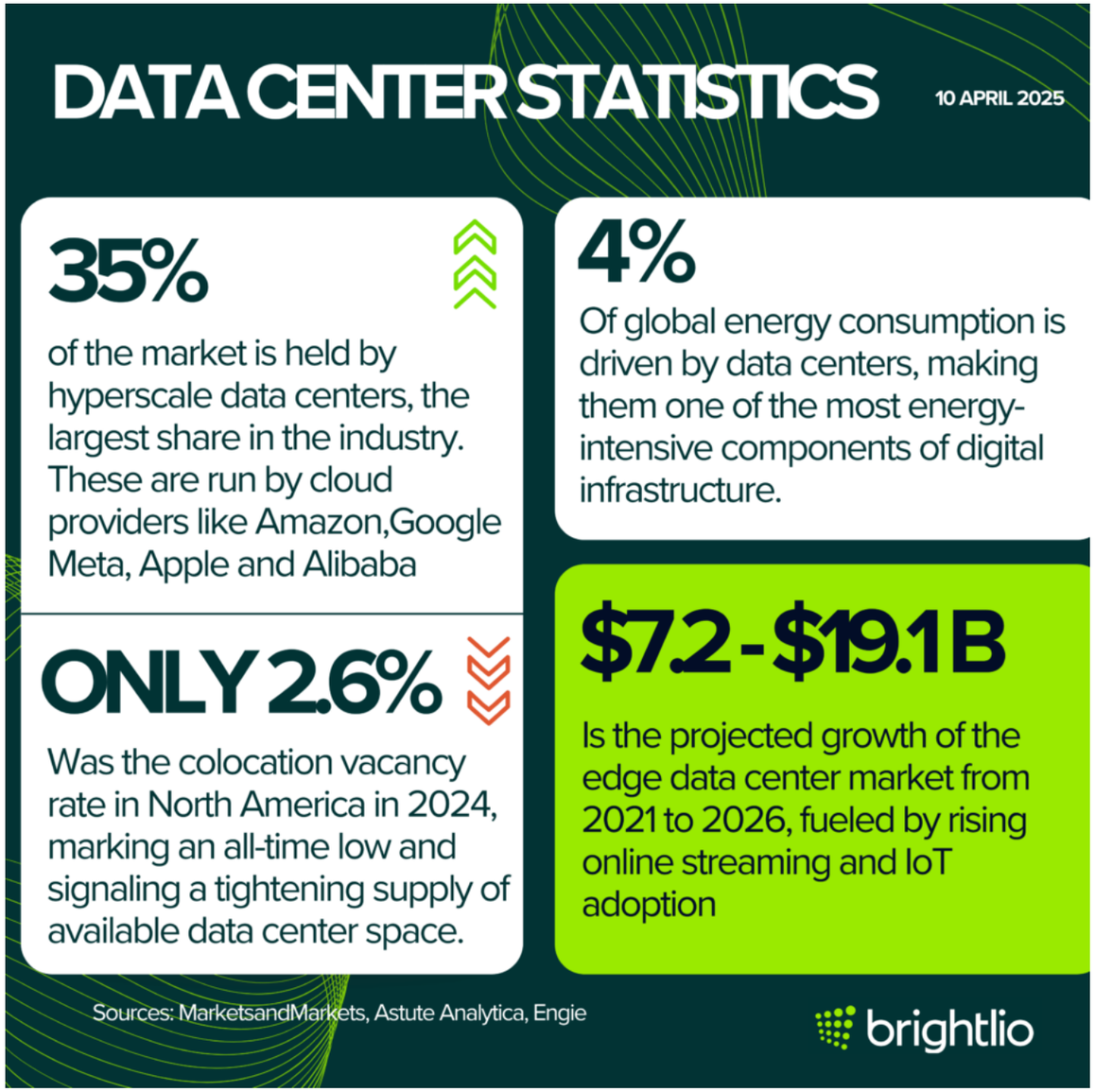
What Is a Data Center?



At its simplest, a data center is a physical facility that organizations use to house their critical applications and data. A data center's design is based on a network of computing and storage resources that enable the delivery of shared applications and data. The key components of a data center design include routers, switches, firewalls, storage systems, servers, and application-delivery controllers.

What Is a Data Center? - Cisco

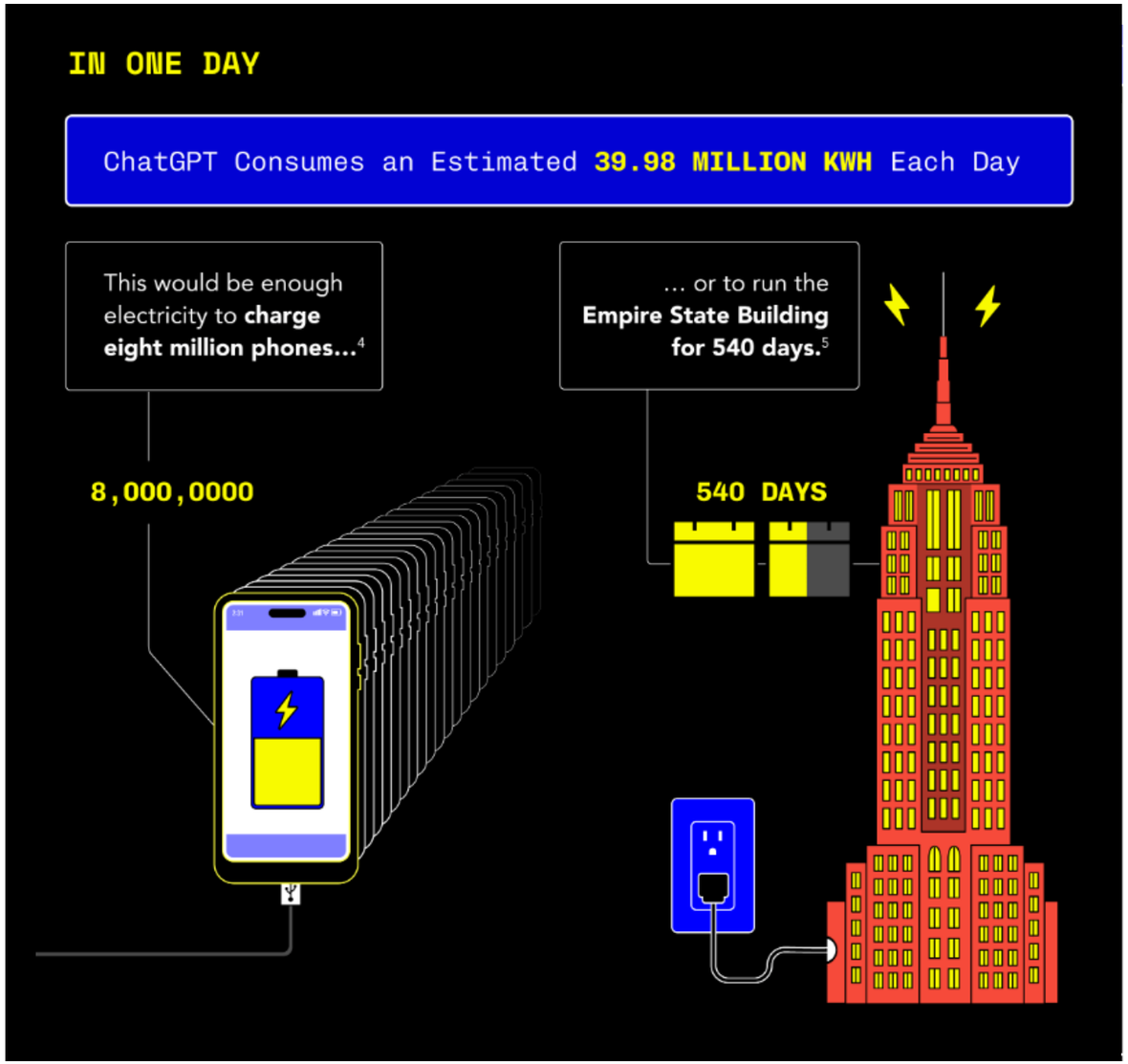
Data Centers – Interesting Figures

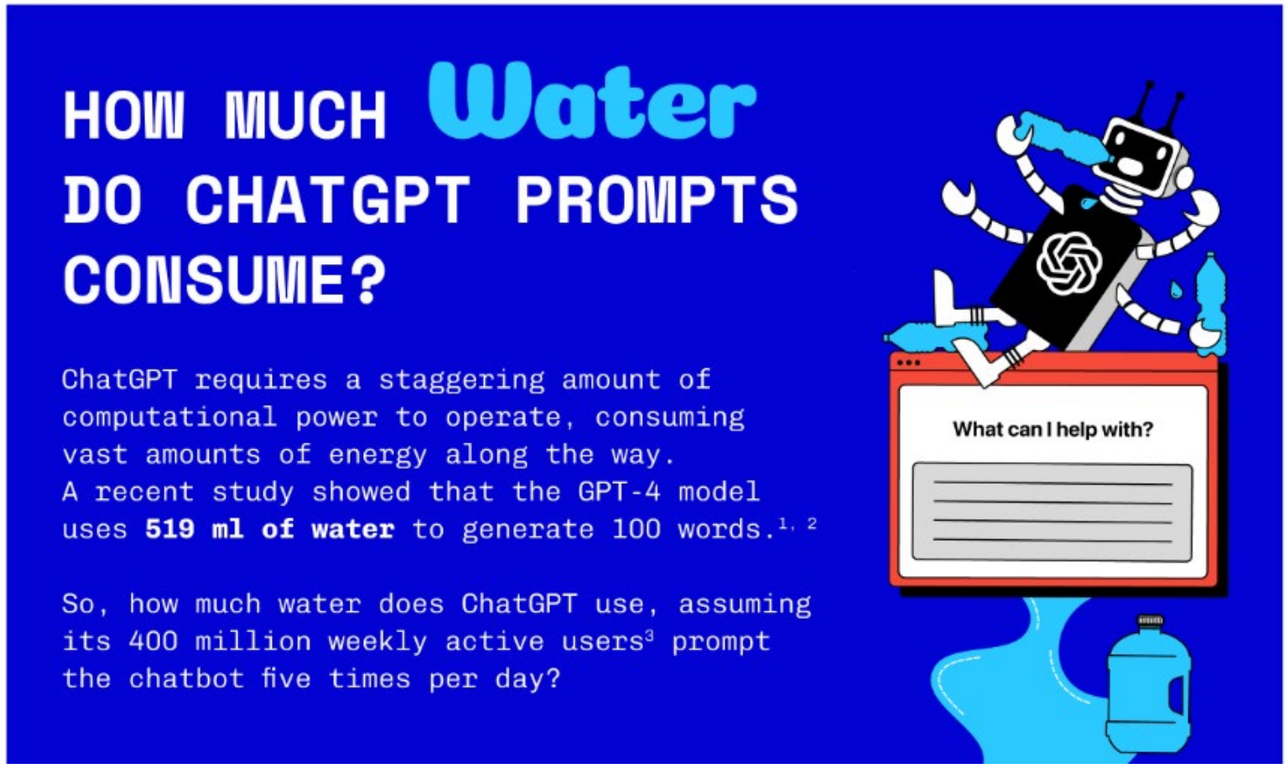


4. The global data center market is projected to reach **$1 trillion** by 2027, driven by the rapid expansion of artificial intelligence (AI) and related technologies. (PWC)
5. Data centers consumed **7.4** Gigawatts of power in 2023, a **55%** increase from the **4.9** Gigawatts in 2022. (Cushman Wakefield)
6. Nvidia's data center revenue exploded by **427**% year over year, jumping from $**4.28** billion in Q1 FY2024 to $**22.57** billion in Q1 FY2025, making it the dominant contributor to the company's record growth. In comparison, all other segments grew less than **50**%. (Statista)
7. In the USA, data centers consume around **1.7** billion liters of water per day, a fraction of the nation's total daily water use (**1,218** billion liters). (Research)
8. Energy use in cloud computing rises by approximately **10**% to **30**% annually. (Digital Reality)
9. The electricity used by data centers could power **6,482,400** average American homes. (Carbon Collective)
10. Data centers account for between **1%** and **5%** of global greenhouse gas emissions. (Channel News Asia)
11. By 2030, global data center carbon dioxide emissions are expected to grow to around **2.5** billion metric tons. (Data Center Dynamics)

215 Data Center Stats (June-2025)

Data Centers – AI Example



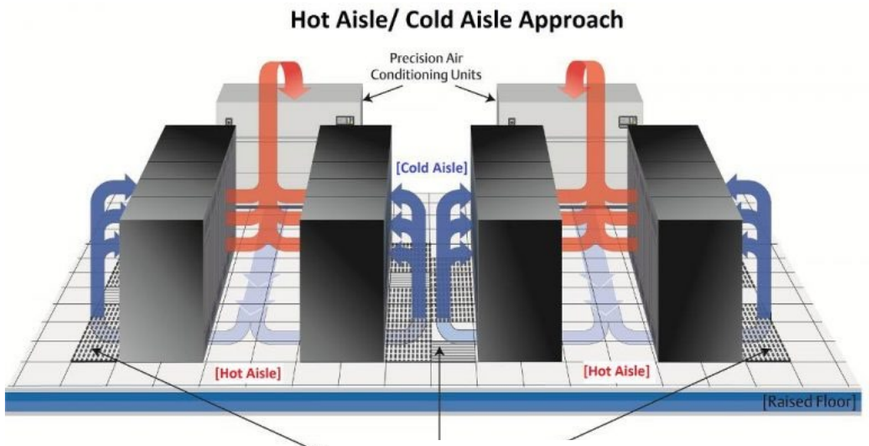


ChatGPT Energy Consumption Visualized - BEUK

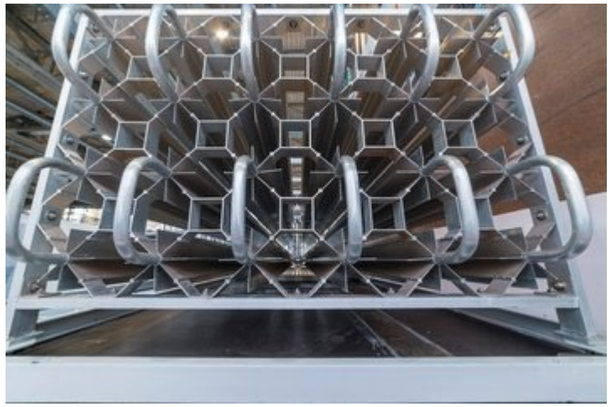
A crescente densidade computacional nos racks do data center: o impacto da IA - CryptoID

How to Build an AI Data Center - by Brian Potter

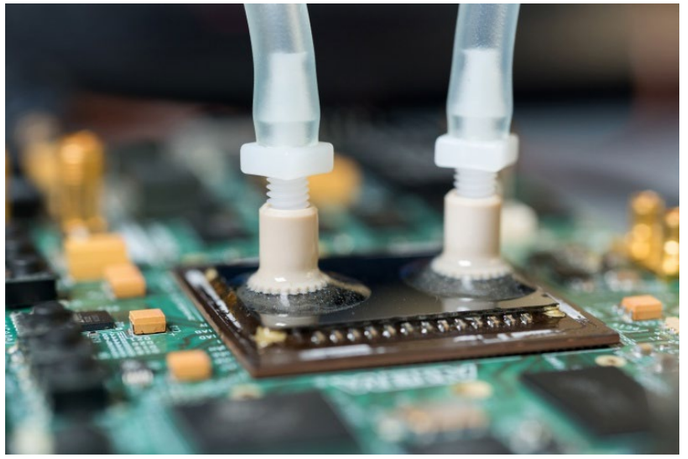
Data Centers – Cooling Methods



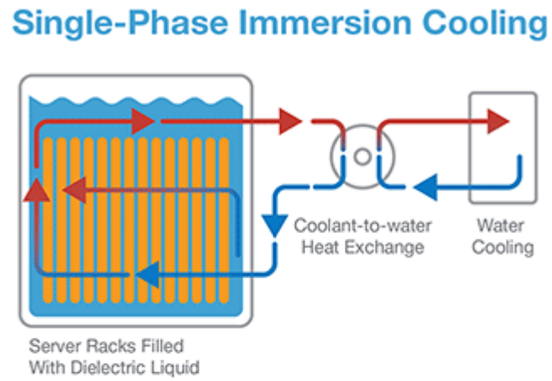
Air cooled

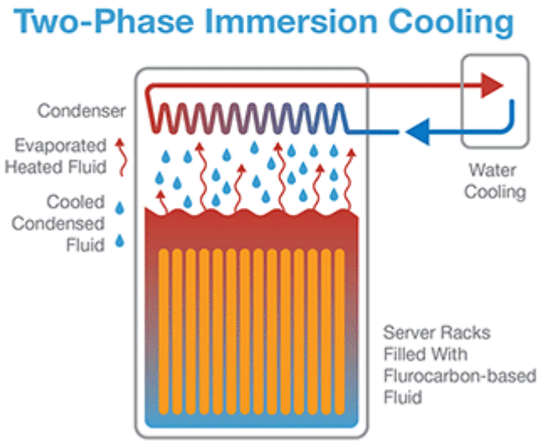


Cryogenic cooled chip



Liquid cooled chip





Full Immersion

Data Centers – Comparison

Air Cooled

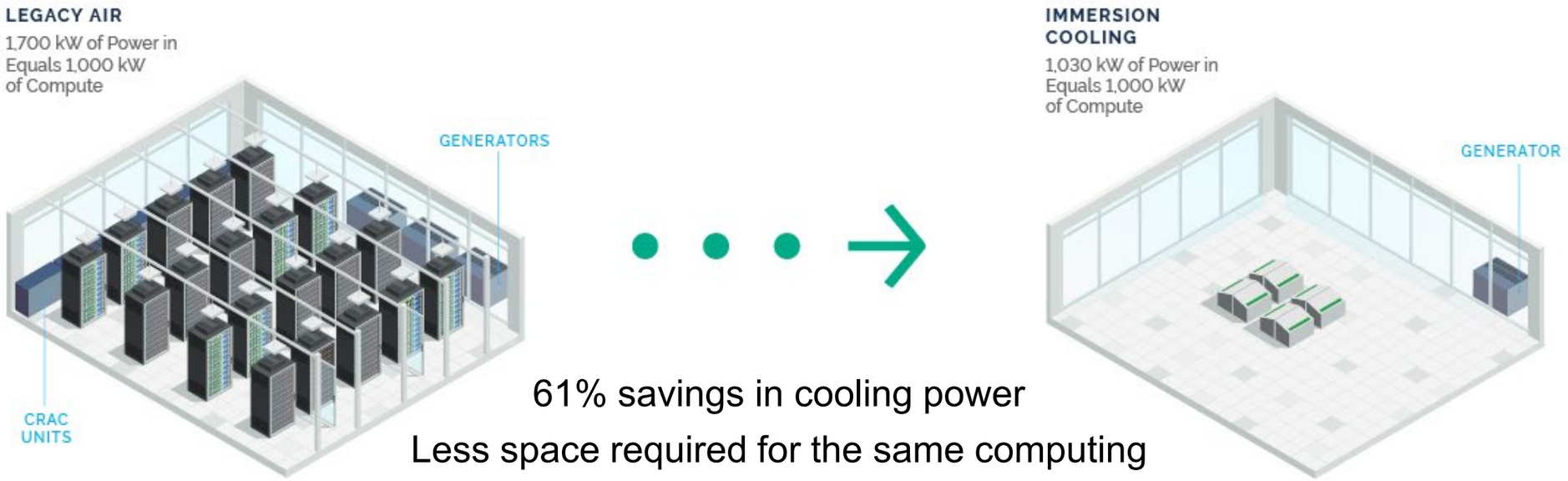
Mechanism:
Uses fans to push air over components, transferring heat to the air, which is then expelled from the system.
Efficiency:
Generally, less efficient than liquid cooling, requiring more energy to maintain desired temperatures, especially in high-density environments.
Density:
Limited by the ability of air to dissipate heat, resulting in lower computing density.
Cost:
Typically, lower upfront cost but potentially higher long-term operating costs due to energy consumption.

Immersion Cooling

Mechanism:
Submerges components in a dielectric liquid that directly absorbs heat, which is then circulated to a heat exchanger for cooling.
Efficiency:
Highly efficient, with dielectric liquids having a much higher heat capacity than air, allowing for more effective heat dissipation and reduced energy consumption.
Density:
Enables higher computing density due to the superior heat dissipation of liquids, allowing for closer component spacing.
Cost:
Can have a higher upfront cost but potentially lower long-term operating costs due to reduced energy consumption and potentially lower maintenance costs.

Data Center Cooling Systems - Benefits, Differences and Comparisons - Park Place Technologies

Data Centers - Comparison



61% savings in cooling power

Less space required for the same computing

Data Center Cooling Systems - Benefits, Differences and Comparisons - Park Place Technologies

Data Centers – Work Temperature

At what temperature should a data center be operated? In 2008, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) expanded the recommended temperature range from 68°F to 77°F (the 2004 level) to 64.4°F to 80.6°F – as measured at the inlet (or front) of the server. Some data centers can be run at higher temperatures.

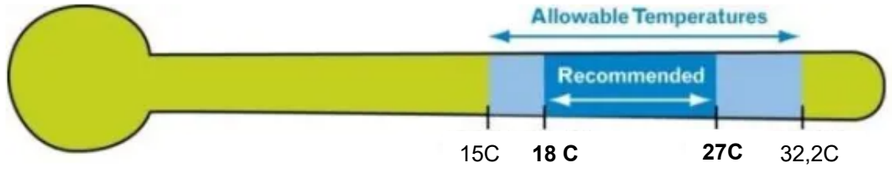


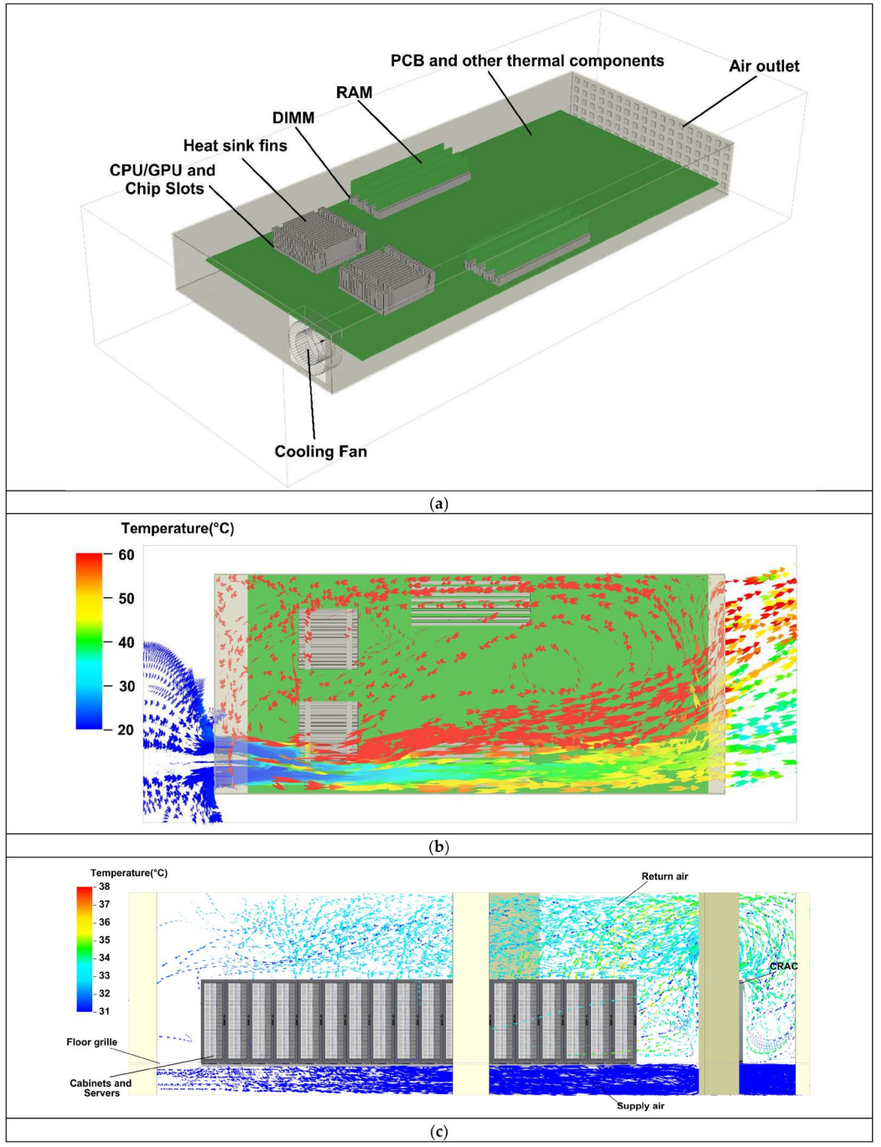
Figure 1: Recommended server inlet temperatures

Savings and Costs

Data centers can save 4% to 5% in energy costs for every 1°F increase in server inlet temperature. As a result, raising server inlet temperatures has been a key component of many data center energy efficiency efforts:

64.4F (18C) ⟶ 65.4F (18.5C)

Raise the Temperature | ENERGY STAR



Improving Thermal Performance in Data Centers Based on Numerical Simulations

Data Centers – Work Temperature

A chilling proposition? How cryogenic chip cooling could aid data center efficiency

Are experiments with cryogenic CMOS about to hit the mainstream?

Most commercially available silicon chips are graded to run from a minimum temperature of 233 Kelvin (-40°C), right up to a maximum 173 Kelvin (100°C). Transistors will switch at what Saligram describes as a "reasonable speed" while operating at room temperature, but performance picks up considerably as temperatures get lower. In a paper published in March 2024, Saligram and his two co-authors, Georgia Tech colleagues Arijit Raychowdhury and Suman Datta, took a 14-nanometer FinFET CMOS device, and optimized and tested it using a cryogenic probe station, focusing on how the transistors performed at temperatures ranging from 300 Kelvin (26.85°C) to 4 Kelvin (-269°C).

"The minimum voltage difference you need to apply in order to take a transistor from on to off at room temperature is around 60 to 70 millivolts (0.06V-0.07V) in the bulk of the devices," Saligram says. "But when you go to cryogenic temperature, this voltage difference can be as low as 15-20 millivolts. That's a 4x reduction in the voltage you need to apply, which is a big difference."

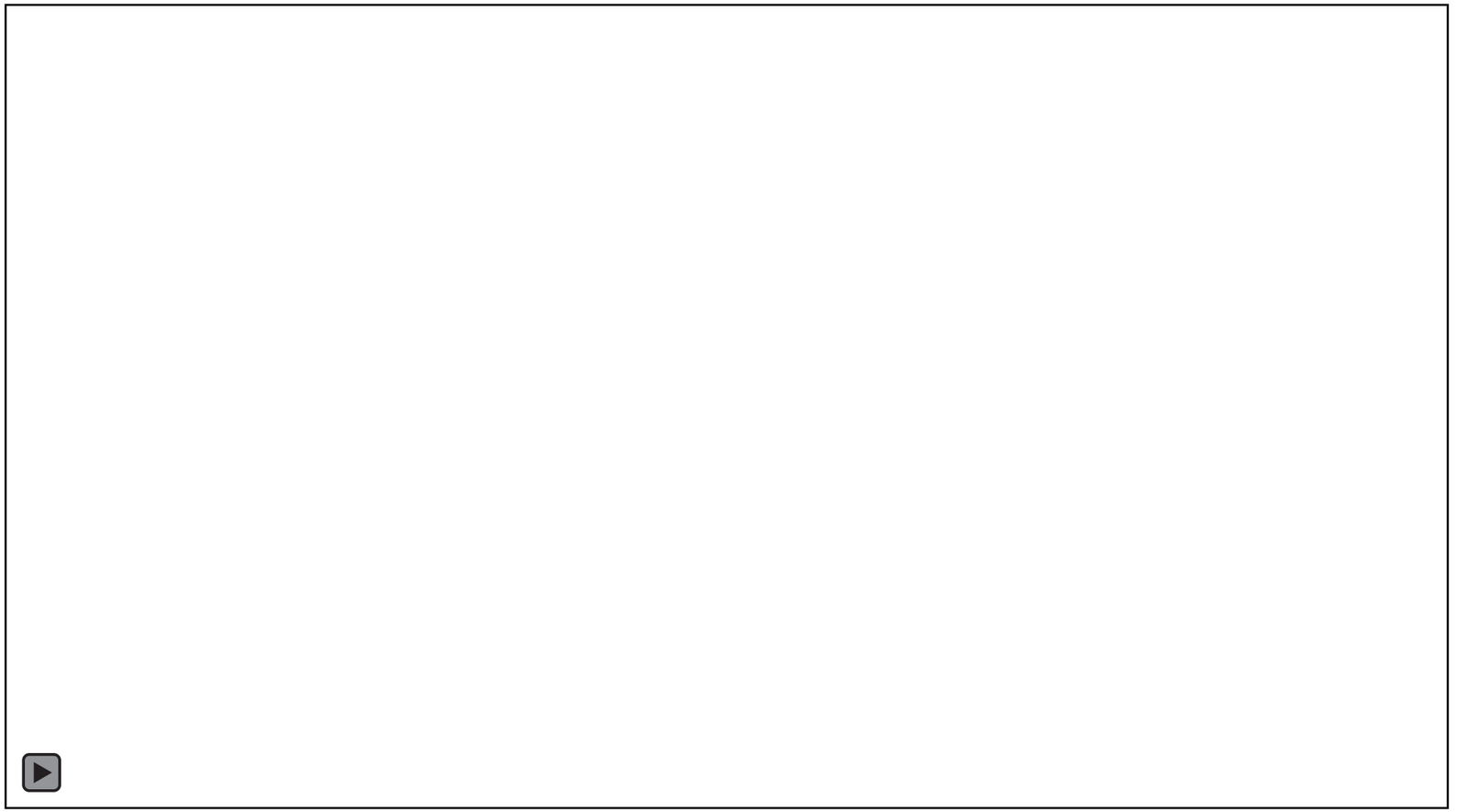
Research is emerging that suggests running complementary metal-oxide-semiconductor, or CMOS, chips at very low temperatures (the cryogenic temperature range is considered to be anything below 120 Kelvin, or -153°C) using liquid nitrogen cooling can lead to increased performance and power efficiency.

Bringing the technology out of the laboratory and into commercial environments will be a challenge, but as vendors seek new efficient ways to cool their increasingly powerful components, this novel

A chilling proposition? How cryogenic chip cooling could aid data center efficiency - DCD

The future is frozen: cryogenic CMOS for high-performance computing - ScienceDirect

Data Centers – Global Temperature



Global Temperature Anomalies from 1880 to 2023

Data Centers – News From Brazil

FITCH WIRE

Brazil's Data Center Industry to Benefit from Policy Support

Thu 15 May, 2025 - 10:24 AM ET

Fitch Ratings-Rio de Janeiro/Toronto/Sao Paulo-15 May 2025: The Brazilian government's new policy proposals could boost the country's attractiveness for hyperscalers looking to establish data centers in Latin America and accelerate the development of Brazil's nascent data center industry, says Fitch Ratings.

Brazil has emerged as Latin America's data center hub in recent years, supported by neutral fiber-optic networks for connectivity and abundant renewable energy sources, making it particularly attractive to companies aiming to reduce their carbon footprints. The Brazilian data center sector has received significant investor interest and issued more than BRL11 billion in corporate bonds since 2021. However, high interest rates, availability of skilled labor, and import taxes on equipment have been constraints to growth.

Brazil's federal government is developing a new national policy on data centers known as *Redata*, which may include import tax exemptions on data center equipment, and a more robust legal framework aimed at establishing the responsibility of AI data centers on data protection and digital security.

The proposed import tax exemption will enhance Brazil's appeal to international businesses looking to establish data centers in the region by significantly reducing equipment costs. Fitch estimates each MW of installed capacity requires around USD10 million of capex by data center operators, while clients invest an additional USD40 million-USD50 million in equipment. Much of this equipment is imported and currently subject to a 100% tax. The proposed tax break could translate to billions of dollars in cost savings for hyperscalers such as Oracle, AWS, Alphabet (Google), and Meta, whose data centers can reach 50MW-70MW each.

Brazil's Data Center Industry to Benefit from Policy Support

Data Centers – Fluids and Properties

Cooling Fluids

Glycols and Water

Water

Dielectric Fluids

Mineral Oils such as GRII/GRIII

Esters

Synthetic fluorocarbons

PolyAlphaOlephin - PAO

Silicon oils

Others

Thermal Properties:

High Thermal Conductivity: This helps the fluid efficiently transfer heat away from components, preventing overheating.

High Flash Point: A high flash point is important for safety, as it indicates the temperature at which the fluid will ignite.

Good Thermal Stability: The fluid should maintain its properties over a wide temperature range.

Other Important Properties:

Low Viscosity: Lower viscosity allows for better flow and cooling, especially in applications like Electrical Discharge Machining (EDM).

Non-Flammability: Minimizing the risk of fire hazards is crucial.

Low Toxicity: The fluid should be safe for operators and the environment.

Chemical Stability: The fluid should not react with other materials in the system.

Material Compatibility: The fluid should not corrode or degrade the materials it comes into contact with.

Cost: The cost of the fluid is an important factor in its overall suitability.

Water Absorption: Low water absorption is important to maintain insulating properties.

Environmental Impact: Biodegradability and other environmental factors should be considered.

Dielectric Fluid - an overview | ScienceDirect Topics

Source: AI generated

Data Centers - Specification

OPEN Compute Project

Base Specification for Immersion Fluids

Revision 1.0, Version 1.0

December 1, 2022

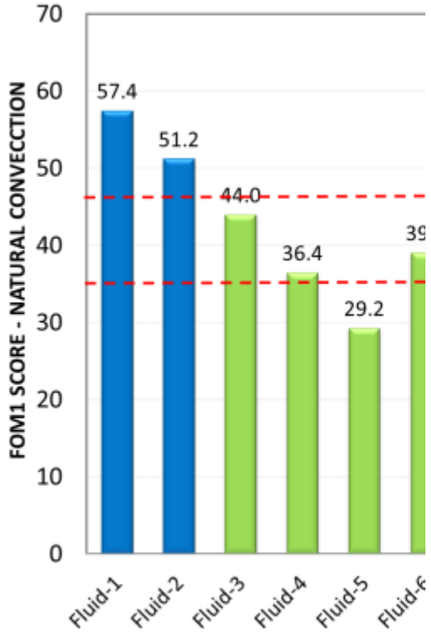


Figure 5: FOM1 Representing Natural Co
(Higher FOI

Parameter	Units	Standard	Spec Value (1P)	Spec Value (2P)
Temperature Specs				
Boiling Point (eng liquids)	°C	ASTM D2887	> 155°C at 1 atm for 1500m altitude use, > 150°C at 1atm for sea level use	> 45°C, < 55°C at 1 atm
Pour Point	°C	ASTM D97	< -30°C	< -30°C
Closed Cup Flash Point (for oils)	°C	ASTM D93	> 155°C at 1 atm for 1500m altitude use, > 150°C at 1atm for sea level use	
Critical Temperature	°C		> 155°C	> 155°C
Auto Ignition Temerature	°C	IEC 62368-1	Refer to IEC 62368-1	Refer to IEC 62368-1
Pressure Specs				
Critical Pressure	MPa	ASTM D6378		
Vapor Pressure	kPa	ASTM D6378	< 0.8	N/A
Figures of Merit				
FOM1 (Natural Convection)[1]			> 45 (Tier2), >35 (Tier1)	N/A
FOM2 (Developing Laminar Flow)[1]			> 19	N/A
FOM3 (Dynamic Viscosity)[1]	N-s/m^2	ASTM D7042	< 0.015	< 0.015
Density[1]	kg/m^3	ASTM D4052	< 2000	< 2000
FOM4 (2P Immersion Fluid)[3]			N/A	> 1.1e6
Electrical Parameters				
Dielectric Strength over lifetime	kV	IEC 60156	> 6 kV/mm	> 6 kV/mm
Dielectric Constant (DK, Er) from 20MHz to 20GHz to 40GHz [2]			<=2.3	<=2.3
Dielectric Loss Tangent (Df, tan δ) from 20MHz to 20GHz to 40GHz [2]			<=0.05	<=0.05
Volume Resistivity	ohm-cm	ASTM D1169	> 1.0e11 ohm-cm	> 1.0e11 ohm-cm
Environmental Parameters				
Ozone Depletion Potential			0	0
Others				
Toxicity			Refer to section 5.1	Refer to section 5.1
Color		ASTM D1500	Refer to section 5.4	Refer to section 5.4
Odor		ASTM E544-18	Refer to section 5.4	Refer to section 5.4

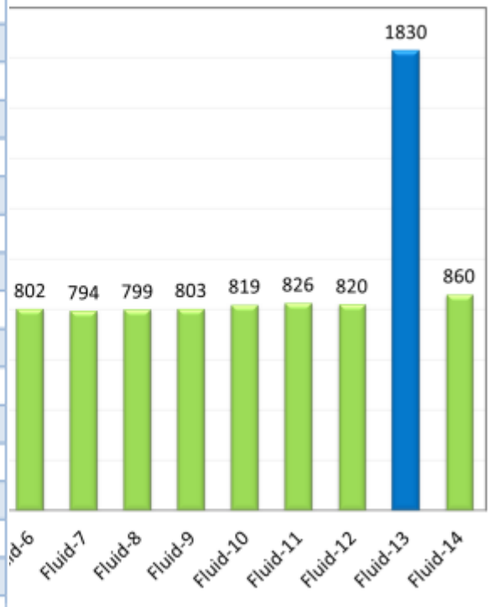


Figure 8: Density of Common Immersion Liquids

https://www.opencompute.org/documents/ocp-base-specification-for-immersion-fluids-20221201-pdf

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Data Centers – Fluid Market

Data center operators are evaluating liquid cooling technologies to increase energy efficiency as processing-intensive computing applications grow. According to the Dell'Oro Group, the liquid cooling market revenue approach $2B by 2027 with a 60% CAGR for the years 2020 to 2027, as organizations adopt more clou… adv… ena…

In 2024, the Immersion Cooling Fluids Market was recorded at a volume of 320 million liters, with expectations to reach 550 million liters till 2028. The synthetic fluids segment dominates with a 45% market share, followed by biodegradable fluids at 30%, and mineral-based fluids at 25%. The synthetic segment's lead is driven by its superior thermal properties and compatibility with advanced cooling systems. Prominent companies in the

Currently, data centers support rack power requirements in excess of 20 kilowatts (kW), but the market is headed to 50 kW or more. Newer-generation central processing units (CPUs) and graphics processing units (GPUs) have higher thermal density properties than previous-generation architectures. In addition, server manufacturers are packing more CPUs and GPUs into each rack to meet the accelerating demand for high-performance computing and AI applications.

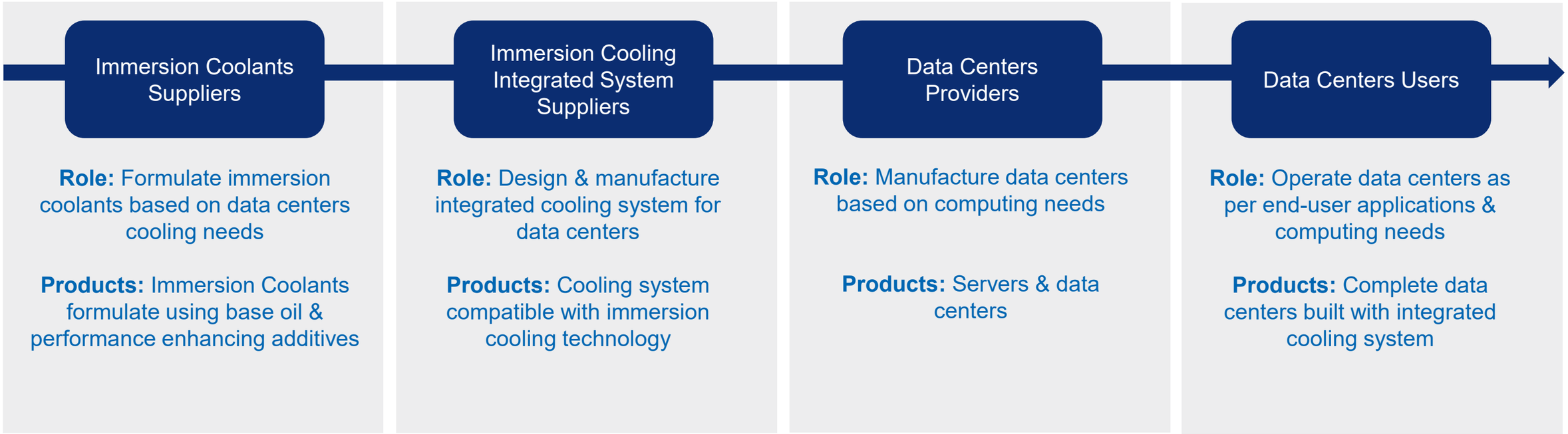
Air processing is now showing its limits. Traditional air cooling can't cool these high-density racks efficiently and sustainably.

As a result, data center operators are investigating their liquid cooling options. Liquid cooling leverages the higher thermal transfer properties of water or other fluids to support efficient and cost-effective cooling of high-density racks and can be up to 3000 times more effective than using air. Long proven for mainframe and gaming applications, liquid cooling is expanding to protect rack-mounted servers in data centers worldwide. Vertiv has created a wide array of resources to help you understand the challenges, opportunities, and technical requirements that liquid cooling presents. These resources will help you decide how to apply and scale liquid cooling across your data center footprint.

Liquid Cooling | Liquid Cooling Options for Data Centers | Vertiv

Immersion Cooling Fluids Market Size, Growth, Trends and Forecast

Data center immersion cooling market definition & value chain



Examples

Immersion Coolants Suppliers	Immersion Cooling Integrated System Suppliers	Data Centers Providers	Data Centers Users
• Shell • 3M • Solvay • Castrol • Fuchs • MIVOLT • Parsa • Bostom Limited • Warkin Equip • Schneider • Hennig Inc	• GRC • Submer • Asperitas • Liquidstack • Fujitsu • Midas Green • Liquid Cool • DUC • Exascaler • Iceotops • Cooler Masters	• Dell • Exellyn • Gigabytes • Kelvion • Rittal Gmbh • Network Techlab • IT Renew	• Google • Microsoft • Apple • Meta • Intel • Lenovo • CGG • VSC

Thank you!