AIM13

Alternative Investment Management, LLC

Data Centers

AIM13

- **What are they?**
  - Massive facilities up to hundreds of football fields in size housing computer systems and storage
- **What do they do?**
  - Process and store enormous amounts of data
- **Why are they crucial for AI?**
  - Provide the computing power to train AI models
  - Store the vast datasets AI needs to learn and improve
  - Enable AI real-time AI inferencing and decision-making at scale

Figure 18: USA represents ~34% of global data center market as measured by number of units, or ~40% of global market as measured by data center power consumption

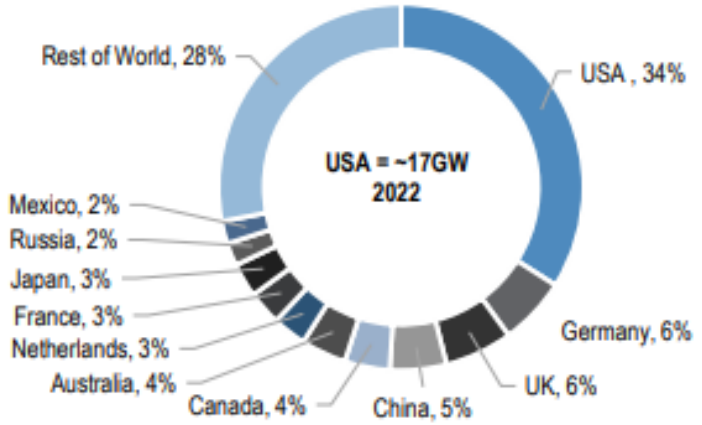


Figure 3: USA Tier 1&2 Cloud Service Providers' data center capex

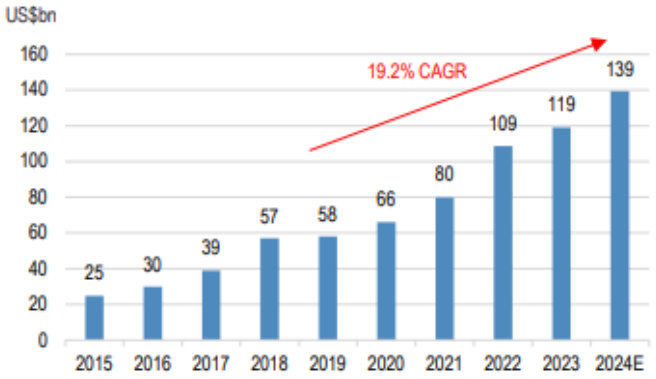
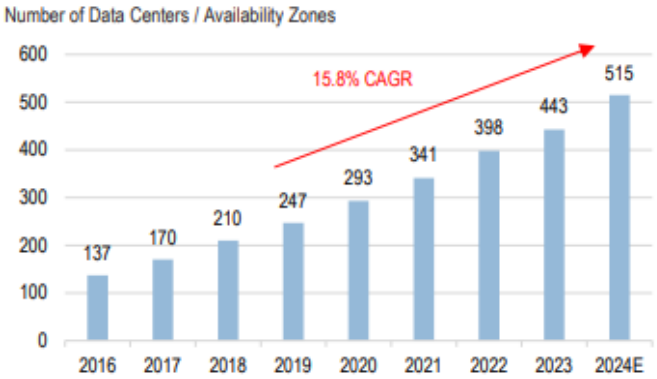


Figure 4: USA CSPs' number of data centers has doubled since 2019



Since 2020, inventory growth in primary data center markets was led by Hillsboro, followed by Atlanta, Northern Virginia, Phoenix, Silicon Valley, Dallas Ft. Worth and Chicago while New York growth was lower at 334%, 118%, 107%, 103%, 69%, 60%, 57% and 29% respectively

Magnificent 7 Paving the Way

Undergoing **data center restructuring**, has lease obligations of **~$6.17 B**

427% YoY growth in data center revenue (78% of total revenue)

Planning to spend **$150 B** on data centers in next 15 years

24% YoY growth in capex (2023)

91% YoY growth in capex

66% YoY growth in capex

Capex has remained stable

*Q1 2024 SEC Filings

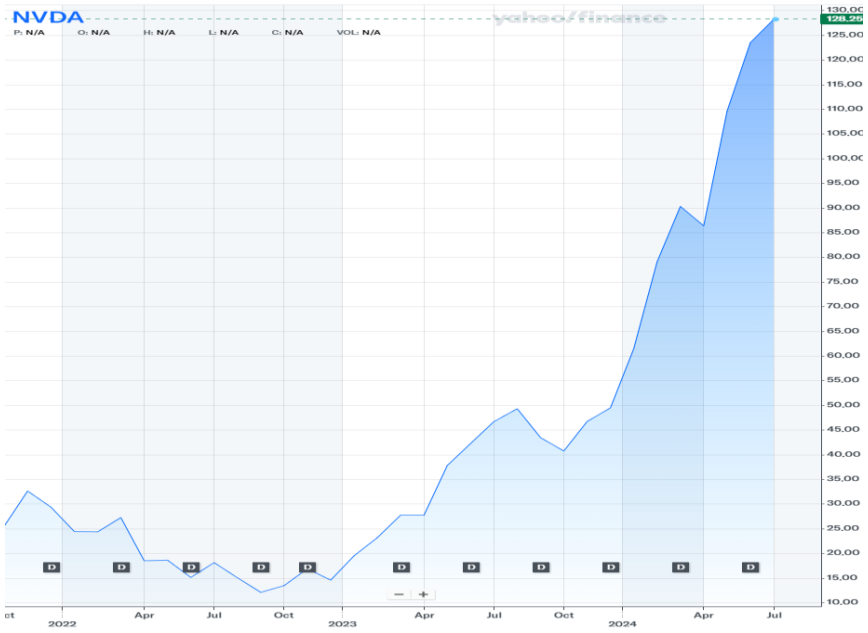
Comparison to Dot-com Bubble

2000

- Top 5 US stocks **15%** of S&P 500's value
- Cisco P/E: **150**
- Cisco average net margin (1996–2000): **17%**
- CSCO rose **700%** during dot-com bubble

2024

- Top 5 US stocks **25%** of S&P 500's value
- Nvidia P/E: **75**
- Nvidia's 5-year average net margin: **27.9%**
- NVDA rose over **500%** since Oct 2022



- Expected growth for data centers has increased overtime
  - McKinsey, 01/23: **10%** CAGR to 2030
  - IEA, 01/24: **15%** CAGR to 2026
  - SemiAnalysis, 03/24: **23%** CAGR to 2026
  - JPMorgan, 04/24: **25%** CAGR to 2026
- AI should account for **~90%** of the growth
  - Total AI compute capacity is growing 50-60% per quarter
- JPMorgan estimates infrastructure market moving from **$22 B in 2023 to $46 B in 2026**

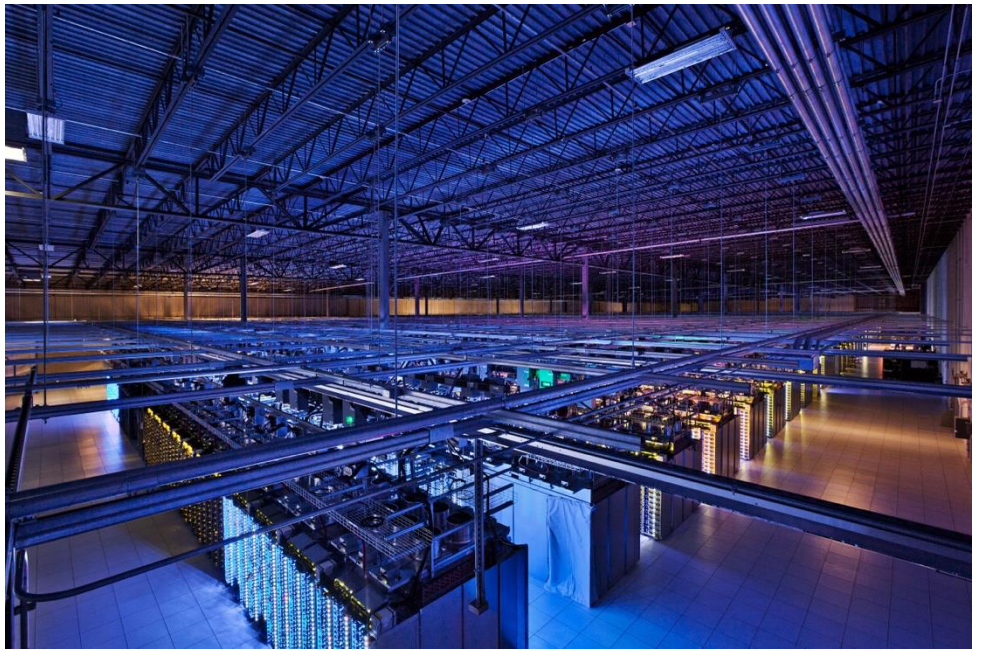
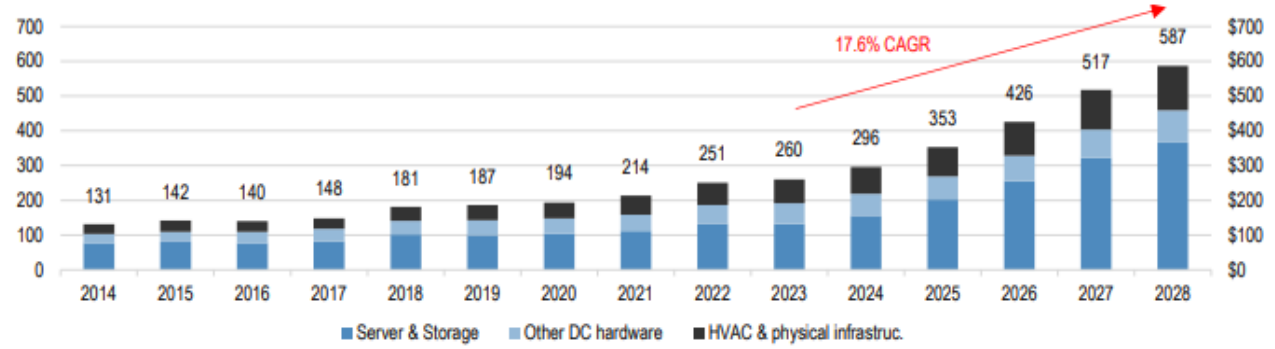


Figure 5: Global data center capex forecast to grow from ~$200bn in 2020, to ~$300bn in 2024, to ~$500bn by 2027 (US$bn)



- **Additional MW per year will grow at 25% CAGR** from 2023 levels to 2026

- Electric Power Research Institute predicts **data centers will consume 4.6-9% of all energy by 2030**

- **Roughly a third of US nuclear power plants** are in talks with tech companies to provide electricity for data centers
  - **Amazon closed deal with Constellation Energy** to purchase nuclear-powered data center for $500 M
  - Deals have potential to remove stable power generation from the grid, concern over massive users of energy getting first dibs

Table 1: Data Center Megawatt (MW) CAGR Estimates

	MW CAGR, '23-'26E
High end	
SemiAnalysis, US only	65%
SemiAnalysis, Global	50%
JPM EE/MI undisturbed server based	30%
Mid Point	
JPM EE/MI efficiency hedged	25%
Low end	
What's embedded in our VRT model	13%
McKinsey/IEA (US only)	10%
VRT company guidance	7%

Energy Estimates

AIM13

Figure 9: Data Center Power Usage In The United States

	Units	2020	2021	2022	2023	2024	2025	2026	2027	2028
AI Data Center Critical IT Power	MW	318	640	1,102	3,332	8,499	16,356	28,140	41,337	56,280
Non-AI Data Center Critical IT Power	MW	14,231	16,395	18,376	19,221	19,798	21,382	23,520	25,637	27,175
Critical IT Power	**MW**	**14,550**	**17,035**	**19,478**	**22,553**	**28,297**	**37,738**	**51,660**	**66,974**	**83,455**
Utilization Rate	%	65%	66%	66%	67%	70%	72%	73%	74%	75%
Critical IT Power Consumed	MW	9,505	11,169	12,826	15,159	19,668	26,983	37,800	49,733	62,688
PUE	Ratio	1.59	1.56	1.53	1.47	1.4	1.34	1.3	1.26	1.22
Data Center Utility Power Consumed	MW	15,142	17,407	19,660	22,323	27,538	36,263	48,957	62,521	76,684
Data Center Actual Power Usage Annually	**TWh**	**133**	**152**	**172**	**196**	**241**	**318**	**429**	**548**	**672**
% of US Power Generation	%	3.3%	3.7%	4.0%	4.5%	5.5%	7.1%	9.5%	12.0%	14.6%

Figure 6: Global electricity demand from data centers, AI & cryptocurrencies - IEA's basecase is 15% CAGR to 2026, upside case is 23% CAGR to 2026

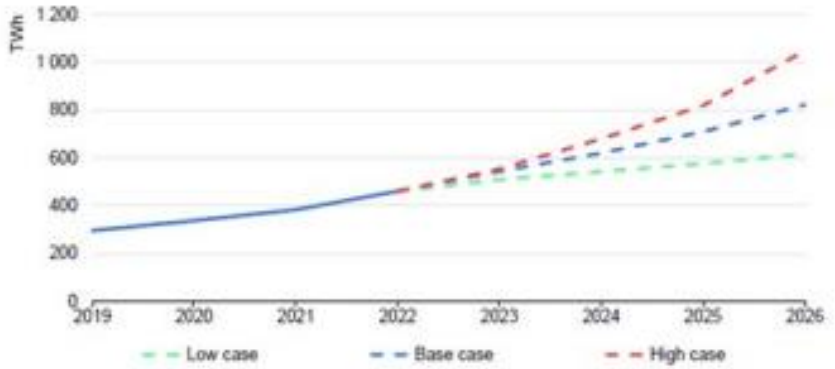
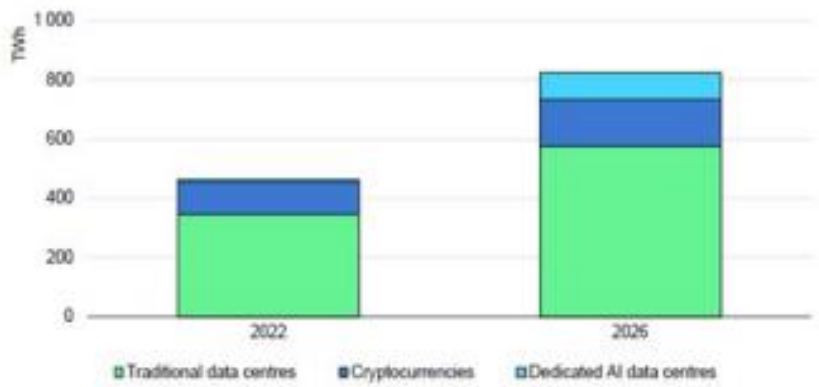
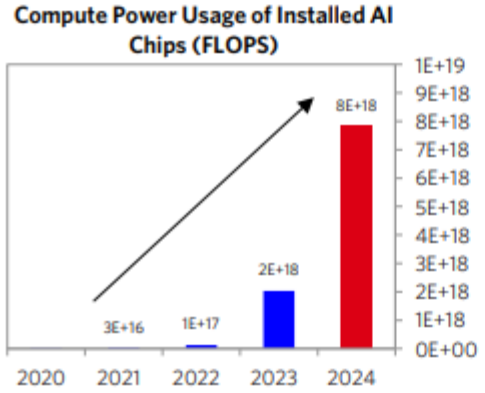


Figure 7: Global electricity demand from data centers, dedicated AI data centers & cryptocurrencies. IEA basecase = ~90TWh of power demand from AI data centers by 2026, equivalent to ~10GW of IT power capacity

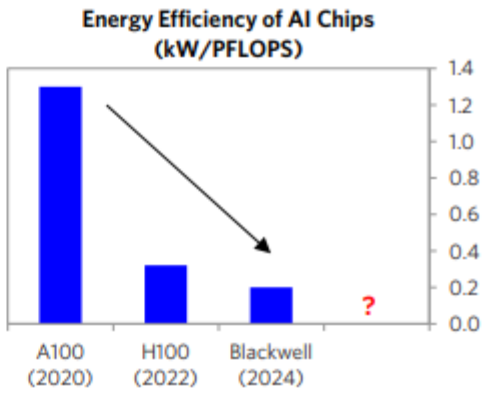


- Energy constraints could **decrease growth estimates by ~30%,** but tech progress could decrease energy needs
  - Uptime institute found that **data center energy usage increased only 6%** between 2006 and 2018, while **compute and storage capacity increased by factors of 6 and 25 respectively**



Source: Goldman Sachs Global Investment Research

AI-related computational demand is rising exponentially as the training and use of LLMs becomes more widespread and models become more complex—but the pace of increase from here is highly uncertain



Rising computational demands are being partially offset by efficiency gains, with newer chips requiring less electricity per computation; it's unclear how these cross-cutting factors will net out in the years ahead

- Average data center construction timeline ranged between **1-3 years until 2020**, and now ranges between **2-6 years**
- Data center's require **20 to 40 tons of copper**

Figure 20: Copper supply - demand, JPM forecast ~4Mt supply gap by 2030, excluding granularity for AI power demand evolution

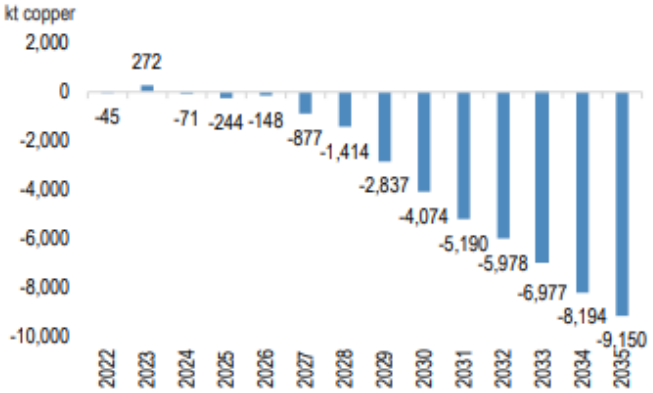
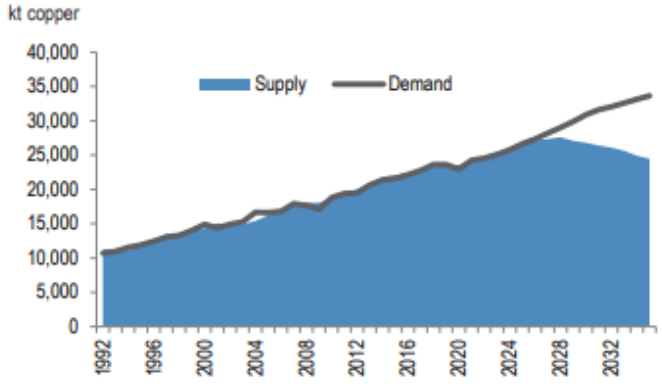


Figure 21: Copper long-term refined copper supply & demand, global mine supply will peak ~2028



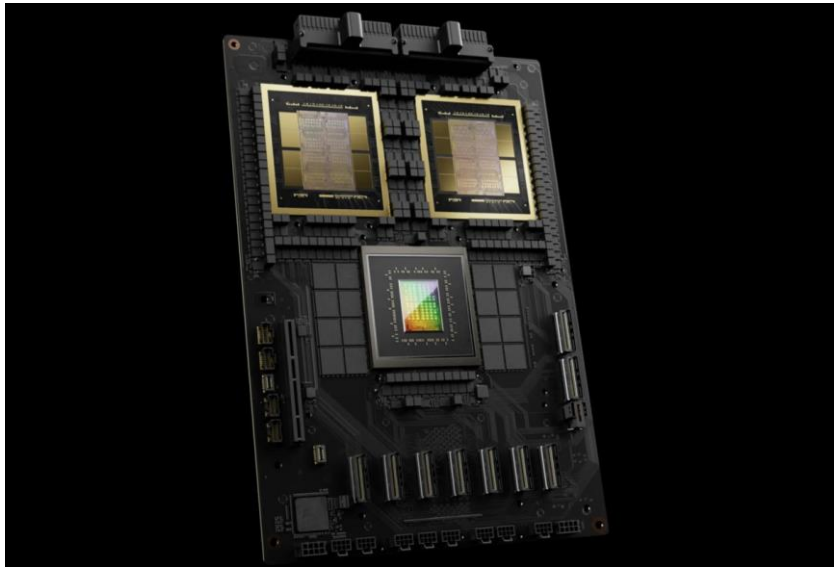
- Major risk is if the **economic output of AI's benefit doesn't near the investment spent**
  - Over the last 18 months **reallocation of money has happened in the trillions** with massive value expected to be gained over the next 10 years

- States pushing for tax incentives for renewable and efficient data centers
  - Virginia, the largest primary market, proposed a data center efficiency bill requiring states to meet **1.2 power usage effectiveness or less** or procure **carbon free renewable energy that equals 90% of their data center electricity**

"AI is not the problem for increasing productivity, but people learning how to use it is."
- Drew Cukor, Co-Head Chief Analytics Office at JPMorgan

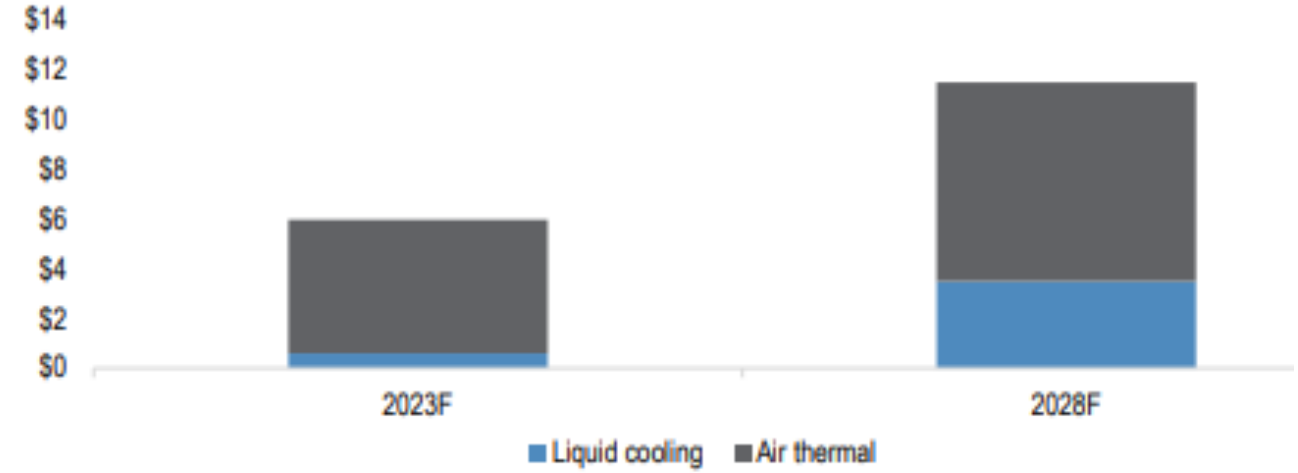
- **Cooling is the fastest-growing expenditure** in running the physical infrastructure of data centers
  - Increasing at 16% CAGR and accounting for 40% of all power used in data centers
- Data centers increasing investments in electricity efficiency to decrease risk of energy constraint
  - Direct to chip cooling has the potential to **reduce power usage per rack by 10%**
  - Cost-effective cooling of high-density racks can be **up to 3000 times more effective than using air**
- Liquid cooling is **needed for certain countries legal restrictions**
  - China targets a **PUE of 1.3** for data centers
  - Several European data centers have agreed to control their **PUE below 1.3**

- In next 2 years, VRT sees **servers rapidly exceeding limits of air cooling**
  - CSP ASIC servers will have **over half of projects this year adopt liquid cooling**
  - AMD's next GPU will have a positive impact on liquid cooling
  - Nvidia's next GPU will adopt air cooling, however, future generations will use more liquid cooling



- Liquid cooling market expected to near **$3.5 B in 2028**
  - Growing from 10% to ~30% of all thermal management spending

Figure 47: Data Center Thermal Management Spending Mix Will Shift Toward Liquid Cooling



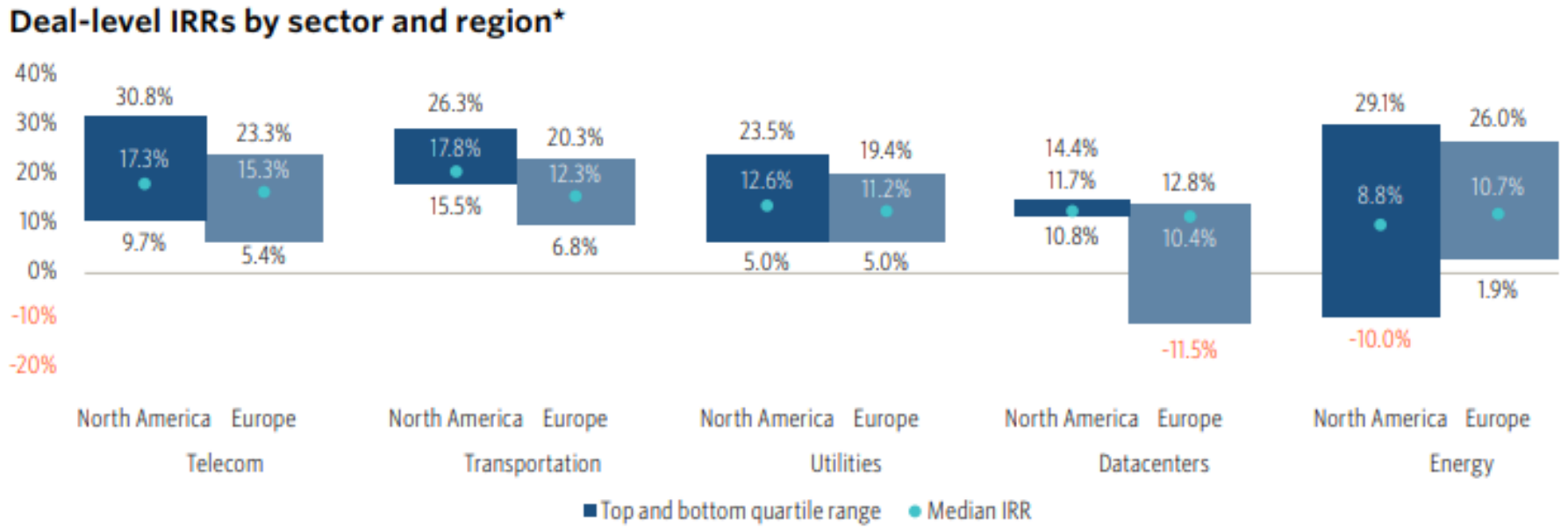
- **Vertiv is a data center infrastructure company** that stands to capture the most share in the growing liquid cooling market
  - **$2 B opportunity in 3-5 years** that VRT can capture 30% of
- **Hubbell is an electricity and utility solutions company** that is most exposed to the power and utility markets associated with data centers

Table 7: EE/MI Exposure to Data Center Market

% of sales

	Data center	Power Utility	DC+Ute
VRT	75%	0%	75%
Schneider	19%	12%	31%
Legrand	15%	0%	15%
ETN	14%	11%	25%
JCI	12%	0%	12%
WCC	7%	23%	30%
DD	6%	0%	6%
Prysmian	6%	35%	41%
TT	~5%	0%	LSD%
ABB	4%	15%	19%
HUBB	3%	57%	60%
Siemens	3%	7%	10%
CARR	LSD%	0%	LSD%
DOV	~1%	0%	~1%

- **Performance of private digital infrastructure over the past decade has been robust** due to support from government and growing demand for telecom and data center capacity



- **$800 B of commitments** to funds with some exposure to digital infrastructure, with **$44 B coming from specialist vehicles focused exclusively on digital infrastructure**

Top Investors

Generalist Funds

Investor	Generalist capital raised ($B) from 2014 to 2023	Generalist fund count from 2014 to 2023	Investor HQ country
MACQUARIE	$56.7	19	Australia
Brookfield	$56.0	3	Canada
EQT	$39.9	5	Sweden
KKR	$33.4	6	US
I SQUARED CAPITAL	$28.4	5	US
GLOBAL INFRASTRUCTURE PARTNERS	$23.8	5	US
Stonepeak	$19.6	4	US
ANTIN INFRASTRUCTURE PARTNERS	$17.9	5	France
AMP CAPITAL	$17.0	6	Australia
Silk Road Fund	$16.2	1	China
ARDIAN	$12.6	4	France
Partners Group	$10.5	4	Switzerland
INFRAVIA	$10.1	5	France
USDA	$10.0	1	US
Morgan Stanley	$9.2	3	US

Specialist Funds

Investor	Specialist capital raised ($B) from 2014 to 2023	Specialist fund count from 2014 to 2023	Investor HQ country
DIGITALBRIDGE	$14.6	5	US
ICONIQ	$5.3	2	US
GRAIN MANAGEMENT	$5.0	4	US
SDC CAPITAL PARTNERS	$4.8	4	US
信金控股 XJ Holding	$3.0	1	Hong Kong
Keppel	$2.1	2	Singapore
PALISTAR	$2.0	1	US
GI PARTNERS	$1.9	3	US
DIGITAL ALPHA	$1.3	2	US
bouwfonds investment management	$1.1	1	Netherlands
sema4	$0.7	1	US
cube	$0.7	1	Luxembourg
CONVERGENCE PARTNERS	$0.5	2	South Africa
Fidelity INVESTMENTS	$0.3	1	US
POST ROAD GROUP	$0.2	1	US