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Sustainability

Powering GenAI: US Alpha Generation as We Head into 2025

As we head into 2025, we focus on upcoming US catalysts, predict evolutions in "time to power" strategies, focus on where we differ from consensus thinking, and provide a few possibly provocative thoughts regarding longer-term technology advances.

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Key Takeaways

- In the US, we see a "36 gigawatt problem": Through '28, we project vast demand for de-bottlenecking solutions — nuclear, crypto conversions and fuel cells.
- Catalysts: nuclear co-location deals, crypto conversions, off-grid strategies, push for power additionality, and data center load flexibility.
- Consensus thinking that Powering GenAI stocks have "had their run" generally looks incorrect; we provide "time to power" math and options-based prob. analyses.
- Morgan Stanley's proprietary options-based prob. analytics tool can be a powerful way to assess underappreciated upside across the Powering GenAI stock universe.
- US Overweights: BE, VST, CEG, AES, NEE, CMI, WDC, JNPR, PSTG, EQT, AR, GEV,PEG, AEP, ETN, CSCO, ANET, ET, WMB, PLD, BX.

2024 has been a transformative year with respect to the rapid growth of Powering GenAI infrastructure, with key solution provider stocks up significantly year-to-date. In this note, we provide our recommendations regarding how to be positioned as we head into 2025. Key takeaways:

1. In this note we include a number of analyses regarding the growth of AI power infrastructure, some of them esoteric. It is easy to lose sight of the big drivers of alpha regarding Powering GenAI in the US — and these drivers are fairly straightforward and very large. There will in our view be a significant shortfall in available US power grid access relative to the magnitude of new data centers needed to "absorb" the AI equipment purchases over the next several years, with the bottleneck becoming apparent in mid- to late 2025. In 2025-28, we project ~57 gigawatts (GW) of US data center power demand, and we quantify available power capacity to serve this demand as: near-term grid access of ~12-15 GW, plus ~6 GW of data centers under construction, resulting in **a ~36 GW shortfall of US power access for data centers in 2025-28. If we extend this analysis through**

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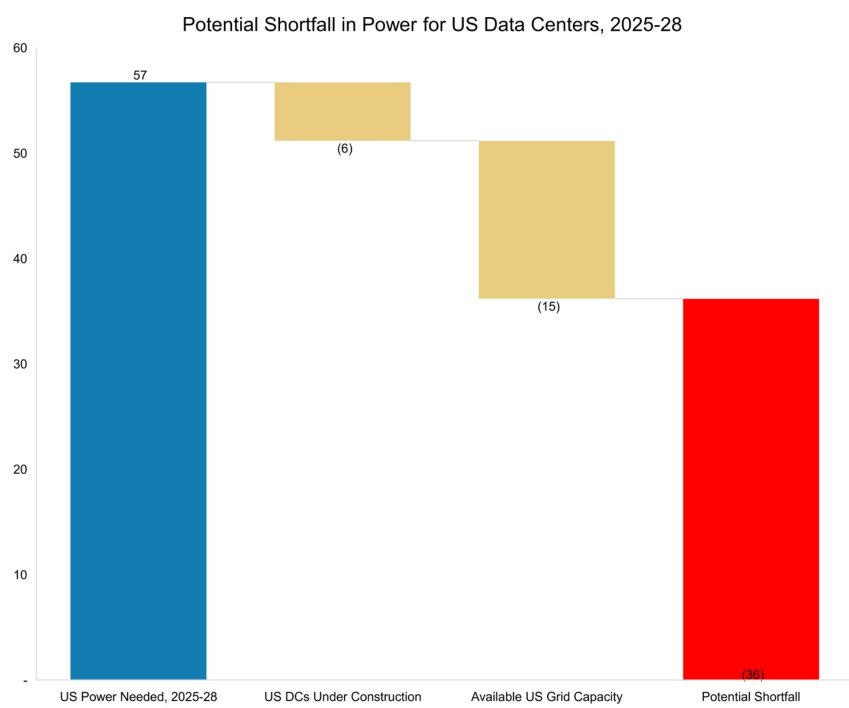
2029, given the ~5 years required to procure and build natural gas-fired power plants (and the time required for utilities to build electric transmission assets), this shortfall could grow to ~60 GW. Potential "de-bottlenecking" solutions include: converting crypto sites to data centers (~12 GW of suitable US capacity — but with a rising Bitcoin price, the required premium to convert is rising, a dynamic we analyze in this note), **siting data centers at large US nuclear power plants** (20-25 GW of suitable US capacity), **siting data centers at operational natural gas-fired power plants** (it is unclear how much capacity is truly available within the next few years — we suspect there is far less capacity available than hoped, driven by grid constraints that we analyze, in markets such as Texas), and **using Bloom Energy (BE.N, covered by Andrew Percoco) fuel cells** (we believe the company could quickly increase manufacturing capacity to ~2 GW per year, with the potential for further increases in output if demand grows, which we believe may well be the case - Bloom Energy is in our view one of the under-appreciated beneficiaries of the rapid growth in data center power demand globally). When we sum up the total "de-bottlenecking" potential and compare this magnitude to the ~36 GW power access shortfall through 2028, **we see concerning signs of a very tight supply-demand balance: the total de-bottlenecking capacity stands at 40-45 GW, assuming all large US crypto sites (operational, under construction and under development) convert to data centers (which is highly unlikely, in our view), and assuming all actionable nuclear plants are used as co-location sites for data centers - in practice, there are many practical reasons why the actual usage of these de-bottlenecking solutions may be more limited.**

The following graphic shows the potential "power shortfall" for US data centers, before considering all available "de-bottlenecking" solutions:

Exhibit 1: We see the risk of a "power shortfall" for US data centers



Source: Morgan Stanley Research

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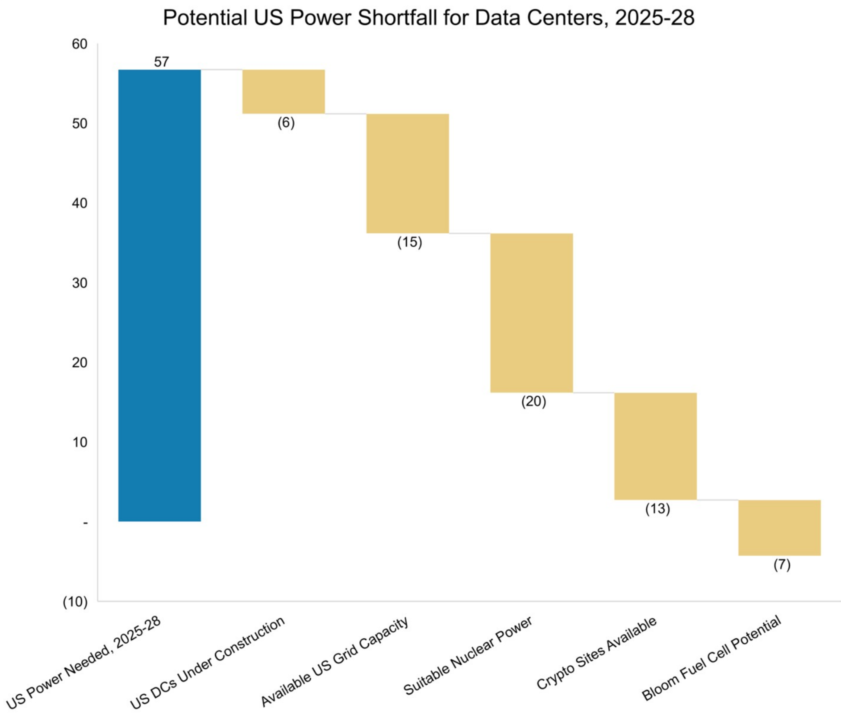
The following graph adds in all available "de-bottlenecking" solutions, excluding natural gas-fired capacity (a topic we discuss at length later in the note):

Exhibit 2: We see significant risk of a US "power bottleneck" from 2025-28 that could impact the pace of data center growth — this chart highlights "de-bottlenecking" solution and suggests that all solutions would need to be nearly fully utilized...and the math gets even more challenging when extrapolating to 2029, when we could see another ~20 GW of data center power demand



Source: Morgan Stanley Research

A couple of frequently asked questions we receive from investors on this analysis:

Why can't new natural gas–fired turbines, or renewables + energy storage, serve this 2025-28 data center demand? In the case of natural gas–fired turbines, it would take ~5 years to build a new combined cycle turbine, and these turbines face limits in terms of "ramping" their power up/down to meet data center power needs (though this could potentially be addressed with energy storage). In the case of renewables + energy storage, this solution is simply not robust enough to serve data center power needs without significant dependence on the grid or other forms of power generation.

Why can't the power grid be expanded to serve this incremental data center power demand? The transmission planning process is extensive (5-10 years), and we see minimal options to shorten/streamline this process. Following a recent large utility sector conference (the Edison Electric Institute conference), US Utility analysts David Arcaro estimates there is 12-15 gigawatts of available grid capacity over the next several years (and utilities in attendance comprise the vast majority of the US power system).

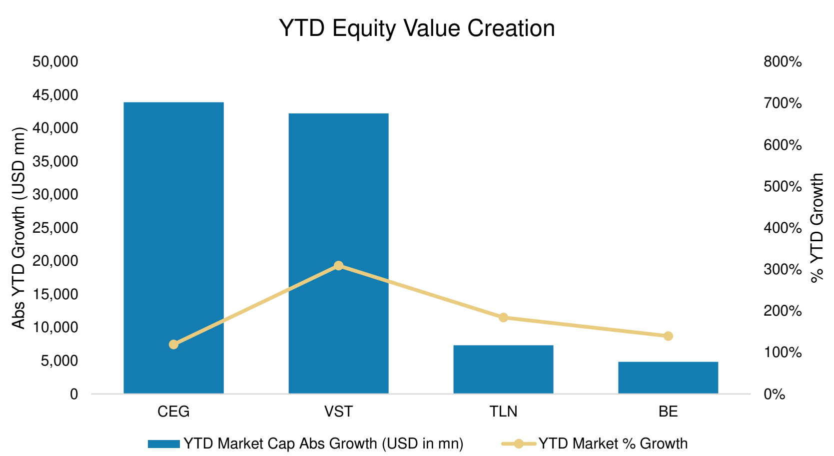
2. We believe the consensus view is not sufficiently bullish regarding the value creation opportunity for companies that can provide "time to power" solutions for data centers. One example of a way to think about the value creation potential: through 2028, if we have a ~36 gigawatt shortfall in terms of US power access, and a 3-year time advantage is worth ~$11/watt based on our analyses (please ask us for a copy of our full Powering GenAI model — this model has a wide variety of capabilities), then the "time to power" solutions providers should be able to generate ~$415b in value (which will be shared with customers to varying degrees). Extrapolating this math through 2030, we see potential value creation of >$980b. Among the key US "time to power" solution provider stocks, YTD equity market value increased a total of ~$98b (excluding the market value increase among Bitcoin stocks, which is in our view reflective of a mix of data center conversion upside and greater bullishness on the price outlook for Bitcoin).

Exhibit 3: Assuming US power needs continue to grow at a 25% CAGR in '28-'30, we estimate that total value creation would be >$980 billion

Potential Shortfall for US Data Centers, 2025-30 and Value Creation	
(-) Est. US Data Center Power Needed, 2025-2030 (GW)	(107)
(+) US DCs Power Capacity Under Construction (GW)	6
(+) Available US Grid Capacity (GW)	15
(=) Potential Shortfall (GW)	(86)
(X) Value of Time Saved in 3 Years ($/watt)	$11
(=) Est. Value Creation for Time to Power Solutions ($ in b)	$988

Source: Morgan Stanley Research

Exhibit 4: Among the key US "time to power" solution provider stocks, YTD equity market value increased a total of ~$98b



Source: FactSet, Morgan Stanley Research. Note: Market cap data as of market close 11/29/2024

Note that we do not include many other companies associated with the Powering GenAI theme in the analysis above, such as GE Vernova, because these companies do not, in our view, provide "time to power" solutions that could shorten the time needed to power up a data center. Many such companies are important in that they provide critical infrastructure ranging from transformers to power plants — but they do not necessarily provide more rapid "time to power" solutions, such as those offered by Bloom Energy, Bitcoin mining companies and the large owners of operational US nuclear power plants.

3. While we have developed a wide range of company-specific analyses regarding the potential upside by providing the infrastructure required for the growth in GenAI, for investors interested in a more comprehensive, thematic, quantitative approach, we believe Morgan Stanley's proprietary options-driven probability tool can be extremely helpful. In a recent note (found here), we showed how this options-driven probability tool can be a powerful way to highlight where Morgan Stanley analyst views are most out of consensus. options-based framework to assess the implied probabilities regarding the likely range of future stock prices, an analysis that we believe has broad applicability to informing the investment decision-making process. **Examples of use cases: (1)** Look for the biggest disconnects between the implied options-derived range of outcomes for a stock relative to an investor's view for that stock. **(2)** Better assess the degree of downside risk, and upside potential, relating to a stock over a given period of time. **(3)** Focus on specific stock catalysts and assess how the market is implicitly pricing the probability, and magnitude of impact, relating to such catalysts.

We applied the Morgan Stanley options-driven probability tool to the entire GenAI Infrastructure value chain, and found a number of stocks where the Morgan Stanley analyst view is significantly more bullish than consensus. For example, the following chart highlights the Overweight-rated stocks where the options market is implying a less than 30% probability of exceeding Morgan Stanley's Price Target over the next 12 months:

Exhibit 5: The following chart highlights the Overweight-rated stocks where the options market is implying a less than 30% probability of exceeding Morgan Stanley's Price Target over the next 12 months

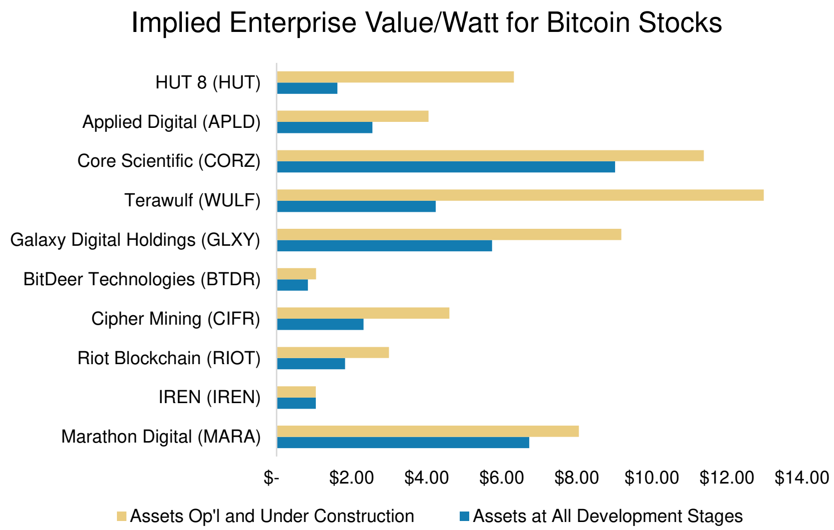
Tickers	Company Name	Options-Derived Probability of Exceeding MS Price Target, Next 12 Months	Upside to MS Price Target	Upside to MS Bull Case
Power Generators				
RWEG.DE	RWE AG	2%	57%	88%
NEE.N	NextEra Energy Inc	24%	19%	46%
ENGIE.PA	ENGIE	4%	26%	39%
CEG.O	Constellation Energy Corporatic	22%	26%	41%
VST.N	Vistra Corp	29%	6%	56%
IBE.MC	Iberdrola SA	15%	15%	22%
Advanced Cooling, Power Electronics				
LEGD.PA	Legrand	16%	16%	32%
Generation Equipment				
BE.N	Bloom Energy Corp.	28%	2%	71%
CMI.N	Cummins Inc	29%	16%	34%
Networking Equipment and Comms. Infrastructure - Fiber, Memory/Storage, Optical.				
WDC.O	Western Digital	15%	37%	74%
PSTG.N	Pure Storage Inc	28%	17%	55%
Nat Gas Suppliers				
EQT.N	EQT Corp.	23%	23%	58%
AR.N	Antero Resources Corp	23%	25%	80%
Other - Construction Services/Design, Developers and Operators, etc.				
SGEF.PA	Vinci SA	5%	30%	54%
TELIA.ST	Telia Company AB	28%	10%	41%

Source: FactSet, Morgan Stanley Research. Note: not all stocks within the theme were included in the analysis due to data limitations; we omitted stocks whose options do not have adequate trading volume and liquidity to support statistically significant calculations. Data as of market close 11/29/2024

4. We continue to see the conversion of Bitcoin mining sites to HPC data centers as a viable "de-bottlenecking" solution, but a rising price of Bitcoin may reduce actionable capacity and increase the cost of conversion. We began writing about this concept before any conversion announcements were announced, starting in April 2024 (see our notes on the topic here, here, and here). We use a different analytical lens in assessing these Bitcoin stocks relative to typical investor approaches, one focused on the capacity of power access held by these companies.

For example, we look at the Enterprise Value/Watt for these stocks, including only the large Bitcoin mining sites that are most attractive to the data center community — the results are informative and suggestive of the potential for further upside for some stocks:

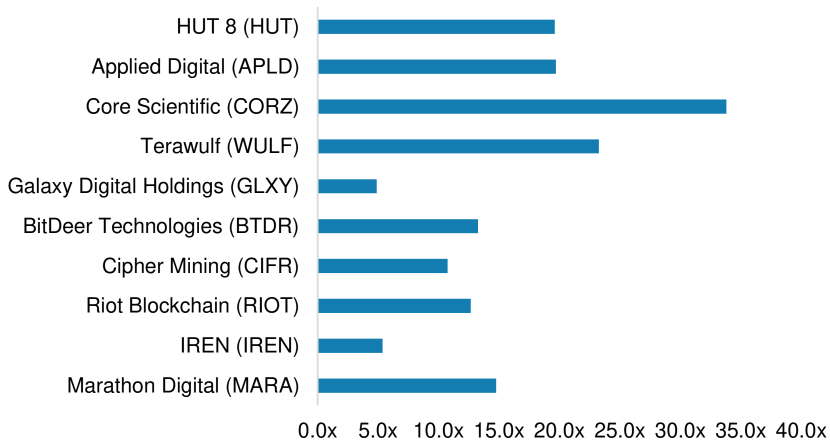
Exhibit 6: Several Bitcoin Stocks Trade at Low Implied Multiples of Enterprise Value/Watt of Owned Power Capacity



Source: FactSet, Morgan Stanley Research. Data as of market close 11/29/2024

We have begun to see transactions in which a data center developer leases power access from Bitcoin companies, and the economics of these transactions have been attractive, in our view. Core Scientific (CORZ, not covered) has been a leader in executing such transactions, which has led to a re-rating of the stock (CORZ stock is up 420% YTD). We expect to see many additional "conversion/rental" transactions in 2025 and beyond, but we could also see other business model permutations that could require significant capital. For example, we believe several Bitcoin management teams may decide to build HPC data center capacity and lease this capacity to hyperscalers or other customers (e.g., large enterprises or sovereigns). We would expect these data center assets to be placed within a REIT structure — this is in our view the most natural investor base for such assets. We believe the value creation related to a "REIT endgame," in which Bitcoin companies transfer their data center assets into a REIT, are not well appreciated. We see 2 drivers of potential upside from the "REIT endgame": higher EBITDA from converting Bitcoin sites to data centers, and a higher EBITDA multiple. The following chart shows the EV/EBITDA multiples, based on consensus EBITDA estimates, for the Bitcoin mining stocks:

Exhibit 7: Enterprise Value/2025e Consensus EBITDA Multiples for the Bitcoin Mining Stocks



Source: FactSet, Morgan Stanley Research. Data as of market close 11/29/2024

A few takeaways from the above exhibit: (i) We would expect these multiples to decline as consensus EBITDA estimates for these stocks to increase for 2025, driven by the recent rise in the price of Bitcoin, and **(ii)** these multiples are much lower than those for data center REIT stocks — DLR trades at ~25.9x NTM EV/EBITDA, and EQIX trades at ~24.7x NTM EV/EBITDA.

In terms of EBITDA upside relating to a conversion of a Bitcoin mining site to a data center, there is a wide range of outcomes depending on the assumed Bitcoin price, as well as the price paid by a data center developer for access to the power. The following analysis shows a range of potential impacts:

Exhibit 8: In terms of EBITDA upside relating to a conversion of a Bitcoin mining site to a data center, there is a wide range of outcomes depending on the assumed Bitcoin price, as well as the price paid by a data center developer for access to the power.

	Current Bitcoin Economics		Post-2028 Halving		Post-2028 Halving - and BTC Mining Equipment Becomes 50% More Power Efficient	
I. Assumptions for mining costs: 1 Bitcoin						
Power cost for 1 Bitcoin in 2023	$ 26,600					
Operational cost for 1 Bitcoin in 2023	$ 5,000					
Total 2023 cost to mine 1 Bitcoin	$ 31,600					
Average power cost ($/kWh)	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05
Power used to mine 1 Bitcoin (kWh)	532,000	532,000	1,064,000	1,064,000	798,000	798,000
Power utilization rate	70%	70%	70%	70%	70%	70%
kW of annual power capacity required for 1 Bitcoin	87	87	174	174	130	130
II. 150 MW Crypto facility analysis						
MW of power capacity	150	150	150	150	150	150
Power utilization rate	70%	70%	70%	70%	70%	70%
Annual Bitcoin production	1,729	$ 1,729	864	864	1,729	1,729
Assumed Bitcoin price	$ 100,000	$ 100,000	$ 100,000	$ 150,000	$ 100,000	$ 150,000
Margin per Bitcoin produced	$ 68,400	$ 68,400	$ 36,800	$ 86,800	$ 52,600	$ 102,600
Annual pre-tax margin ($m)	$ 118	$ 118	$ 32	$ 75	$ 91	$ 177
Tax rate	21%	21%	21%	21%	21%	21%
After-tax margin ($m)	$ 93	$ 93	$ 25	$ 59	$ 72	$ 140
Data Center Annual Net Lease Rate ($m/MW)	$ 0.50	$ 1.00	$ 0.50	$ 1.00	$ 0.50	$ 1.00
Net Pre-Tax Margin from Leasing Site to DC Developer	$ 75	$ 150	75	150	75	150
Accretion from Leasing Site to DC Developer	-37%	27%	136%	100%	-18%	-15%

Source: Morgan Stanley Research

While annual margin accretion/(dilution) is a useful tool in assessing value creation from converting a Bitcoin site to a data center, there are important differences in duration of cash flow that should also be considered. For example, for a Bitcoin site, following the next "halving" event that will occur on March 26, 2028 — following every halving event, the reward for mining a new block of Bitcoin is cut in half. This dynamic is shown in the preceding exhibit — the margin for a Bitcoin mining facility would fall significantly unless we see a very large increase in the price of Bitcoin, because it takes twice the power to produce a single Bitcoin. For this analysis, we hold the power efficiency of the Bitcoin mining equipment constant in the middle portion of the analysis, and then shift to an assumption of a 50% improvement in the power efficiency of the Bitcoin mining equipment (there is significant historical data charting this improvement in power efficiency). Note that the far right portion of the analysis, factoring in improved power efficiency of the Bitcoin mining equipment, does not factor in the capital cost of the new mining equipment.

The bottom line of this analysis: there is significant risk, in our view, that Bitcoin mining management teams may decide not to convert the majority of their sites to data centers, unless the lease rates for doing so are relatively high. For example, the lease rates, net of cost to Core Scientific, have been less than $1/watt per year. This in turn may increase the value of other "de-bottlenecking" solutions such as nuclear power plant sites (CEG, VST, and TLN being the biggest US beneficiaries) and Bloom Energy's fuel cells.

5. We may see increasing "off grid" approaches to powering data centers. Given the increasing time required to connect to power grids, especially in the US, we believe there could be more upcoming "off grid" approaches to powering data centers. The mathematics are interesting. For example, batteries and smaller gas-fired turbines could be combined with large combined cycle natural gas turbines to provide a robust power source, and this cost might not be prohibitively expensive. If we assume a fully-installed capital cost in Texas of $1,300/kW, and assume 1.2:1.0 backup generation ratio with a fully-installed cost of backup combustion turbine generation of $1,000/kW, the all-in required revenue would be $105/MWh, a number that is quite similar to both the likely revenue from behind-the-meter nuclear-powered data center deals (in our view), and also similar to Bloom Energy's ~$100/MWh revenue requirement for its fuel cell solution. Markets where we would expect to see "off grid" data center power solutions: California (where **BE**'s fuel cell is well positioned) and Texas (where both traditional turbine providers such as **GEV, CMI, CAT, 6503.T,** and **ENR.DE** are potential beneficiaries, and where **BE**'s fuel cell could also be a solution).

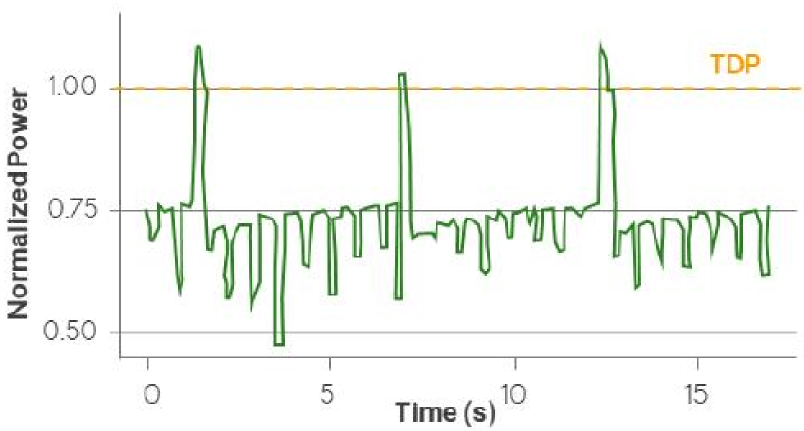
We believe we could see much greater corporate and investor focus on "microgrids" in the context of data center developments. For example, we believe Bloom Energy could provide a microgrid solution to data center developers. What exactly is a microgrid? There are various permutations, but at its core, a microgrid is, as Bloom Energy states, "a localized grid that can disconnect from the traditional grid to operate autonomously. Microgrids are becoming increasingly important because they allow critical loads, facilities or even entire communities to continue operation when the surrounding electrical grid becomes unavailable." There are multiple use cases for microgrids:

Exhibit 9: According to Bloom Energy, there are multiple use cases for microgrids

Source: Bloom Energy

We believe Bloom Energy's fuel cell microgrid solution, known as AlwaysOn, has several important benefits: (i) high quality power, (ii) high reliability of the equipment, (iii) relatively small unit size, with the result being high redundancy in the event of a single unit failure, (iv) high power density, and (v) a high degree of flex in the magnitude of output, allowing Bloom's fuel cells to closely match the variable power demand profile of HPC data centers. Regarding that last advantage, we believe the market does not fully appreciate the importance of rapid ramping requirements for data center power supplies — Bloom Energy provided an example of a HPC data center profile, adapted from a research report (found here):

Exhibit 10: We believe the market does not fully appreciate the importance of rapid ramping requirements for data center power supplies — Bloom Energy provided an example of a HPC data center profile



Source: Bloom Energy

The load following advantages of Bloom Energy's fuel cells were described by the company in a White Paper: "For several reasons, fuel cells outperform their rotating machine counterparts regarding response time for ramping from part load to full load. Fuel cells simplify the energy conversion process. Unlike traditional power generation methods that use rotating machinery such as gas turbines and require a multi-step conversion from chemical to electrical energy, fuel cells accomplish this transformation directly in a single step."

6. We believe we may see a "bridge" approach to data center development, in which temporary, mobile generation is deployed in order to address "additionality" requirements. We believe that in some jurisdictions, the concept of "additionality" will become important with respect to new data center development. This is a topic we have explored in depth (note found here). We believe we will see a mandate from some policymakers around the world for "power additionality" in conjunction with new data center development - specifically, that Data Center developers also bring to the table new power generation resources to help alleviate power grid pressures from the large power demands of new, larger HPC Data Centers. Over time, as grid connection requests are granted, the mobile generation can then be used to expand the size of the data center project (by utilizing the newly secured grid access and the onsite generation), essentially allowing very large data center projects to "ladder" into increasingly large volumes of power access. The biggest challenge with this strategy is the increasingly long lead time associated with procuring a wide range of natural gas turbines. **This could lead to further capacity expansions of turbine manufacturing capacity (coupled with potentially higher margin sales contracts)**, and on the margin would benefit on-site generation technologies with shorter lead times (such as **Bloom Energy's** fuel cells).

7. In the US, we could see a widening divergence in degrees of "strict additionality" required by different power sector regulators - and we believe this requirement will limit the extent to which existing, operational natural gas-fired power plants may serve as "de-bottlenecking" solutions over the next few years. We believe we will see a wide range of "additionality" approaches taken by power grid regulators. For example, we believe we may see relatively "strict additionality" in Texas, while other US power markets are far less likely to require this and instead would look favorably upon new generation announcements (such as SMR nuclear projects), even if those projects would come online after new data centers are connected to the power grid. Under "strict additionality," such as what we believe we will see in Texas, the regulator would effectively mandate that new data centers cannot be energized until new power generation is connected to the grid (unless a data center is willing to go through the more standard grid interconnect process, which would often be quite lengthy because the grid operator would want to see total new generation and transmission be sufficient to serve all new proposed sources of power demand). **What will drive the trend towards "additionality"? (1)** growing political concerns with the potential that new data centers will drive up the price of power for all consumers, and **(2)** concerns from power grid operators that the large power usage of new HPC data centers could jeopardize grid reliability, especially in markets in which renewables growth has been rapid, weather extremes have increased and the addition of new controllable power generation (such as nuclear and natural gas) has been relatively small. An example of a recent statement from a key policymaker: **the Chairman of the Public Utilities Commission of Texas (PUCT), Mr. Gleeson, recently stated:** *"We can't afford to lose any of our resources of the system…we are telling data center developers **they will need to supply some of their own power** … [they] can afford to **fund construction of new power plants."*** Beneficiaries in "strict additionality" markets would include fuel cell manufacturer **BE.N**, as well as manufacturers of smaller, more mobile natural gas-fired generators (as per trend #1, **GEV, CMI, CAT, 6503.T,** and **ENR.DE**). In power markets where "strict additionality" is not a requirement, we believe we could see a significant volume of renewables, energy storage and new nuclear power solutions. **Key potential beneficiaries in these power markets:** leading US renewables developers (**NEE** and **AES)**, leading European renewables companies with exposure to the US such as (**EDPR, Orsted, RWE,** and **ENGIE**), nuclear power players with significant "uprate" potential (**CEG** — the company could potentially increase the capacity of its existing nuclear fleet by ~1,000 megawatts) and Small Modular Reactor companies (**OKLO, SMR, RR,** and **NNE**).

While we appreciate the potential to build data centers behind-the-meter at operational power plants, and we are seeing a large volume of such projects in development in markets such as Texas, we believe there will be significant grid-related challenges that may slow these proposed projects. The power challenges in Texas (ERCOT) serve as a useful example. Organic power demand growth in ERCOT is quite high (likely greater than 4 GW per year, in a market with peak demand of ~85 GW), and new construction of controllable generation is low for the next several years (ERCOT is tracking 5.6 GW of gas combined cycle plants and 18 GW of peakers that have requested interconnection, but only 785 MW CCGTs with signed interconnection agreement through 2028 and 718 MW of peakers). If we in fact see a vast number of behind-the-meter data center projects get announced at natural gas-fired and nuclear power plants in ERCOT, we believe the utility regulator (PUCT) and grid operator (ERCOT) could raise grid reliability concerns, along the lines of concerns raised by PUCT Chair Gleeson recently. Given it takes ~5 years to build and interconnect a natural gas-fired power plant in Texas, we believe that there is a significant risk of an increasingly strict “power additionality” requirement in ERCOT. This in turn would, in our view, increase the value of Bitcoin mining sites in Texas, as well as behind-the-meter data center projects in other markets that face less severe grid reliability challenges (potentially the nuclear power plants owned by CEG, VST, and TLN in certain states in the PJM power market that have ample power supply such as Illinois, Pennsylvania, and Ohio). For a recent analysis of the potential value of nuclear generation, see our recent note here.

8. We expect to see a growth surge in decarbonization solutions to help hyperscalers achieve their carbon reduction goals, and many of these companies have received little investor interest to date. We recently assessed that the data center build-out could potentially result in additional cumulative 2.5Gt of CO_2eq. by 2030. We believe this carbon footprint is larger than appreciated as hyperscalers have large and complex Scope 3 emissions and will need to take an "all-hands-on-deck" approach in order to meet their ambitious 2030 carbon neutral targets (actions that extend beyond clean power procurement and into clean materials procurement). We expect that in order to meet sustainability goals, hypercalers will drive significant investment into green steel, green cement, carbon capture and storage (CCUS) and carbon removal technologies (including everything from reforestation up to Direct Air Capture, or DAC). Potential beneficiaries of such investments are highlighted in our recent note — *Global Data Centers: Sizing & Solving for CO_2*. We include a list of the companies highlighted in the note above and those stocks that are part of our regional preferred sustainable stock ideas product: AES Corp. (**AES.N,** covered by David Arcaro), NextEra Energy (**NEE.N,** covered by David Arcaro), and First Solar (**FSLR.O,** covered by Andrew Percoco) in the Americas; SSE (**SSE.L,** covered by Robert Pulleyn), Siemens Energy (**ENR1n.DE**, covered by Max Yates), and Legrand (**LEGD.PA,** covered by Max Yates) in Europe; and Kansai Electric Power (**9503.T,** covered by Reiji Ogino) in Asia. It is also worth flagging GE Vernova (**GEV.N,** covered by Andrew Percoco) as a key data center decarbonization solution stock.

We would also note the large recent contract between Microsoft (MSFT) and Constellation Energy (CEG), the US' largest owner and operator of nuclear power plants, in which a shut down nuclear power plant will be restarted by CEG — and Microsoft will purchase the power from this plant at above market power prices. The statement from Pennsylvania Governor Shapiro was interesting, and in our view highlights that this announcement may well be in conjunction with an upcoming announcement in which MSFT will build a large Data Center complex at an operational CEG nuclear power plant — **Governor Shapiro's letter to PJM, the regional grid operator, reads, in part:** *"[T]here is a* ***demonstrated need for more electrons on the grid as electrification and data center demand increases.…*** *My Administration is committed to … embracing an 'all of the above' energy strategy that creates jobs, reduces emissions and ensures safe, reliable affordable power for Pennsylvanians for the long term."*

9. We believe we will see significant demand for new natural gas–fired power generation and related infrastructure. When we look at the hot spots of Data Center development, in the US and around the world, we see a significant overlap with regions that have favorable policy support for natural gas. For example, in a recent note recapping our takeaways from a Texas field trip, we noted the massive amount of development of "behind the meter" Data Centers that will likely be located at operational natural gas–fired power plants. We would also highlight that Texas has a subsidized loan program that will encourage the construction of additional natural gas-fired power generation in the state. As we highlighted in our recent Texas note, the stocks exposed to strong natural gas-fired power generation growth are: **(A)** natural gas power generation equipment manufacturers - GE Vernova (**GEV.N,** covered by Andrew Percoco), Siemens Energy (**ENR1n.DE,** covered by Max Yates), Mitsubishi Power — a power solution brand of Mitsubishi Heavy Industries (**7011.T,** covered by Yoshinao Ibara); **(B)** US natural gas players benefiting from increased demand — our US Energy team sees EQT (**EQT.N,** covered by Devin McDermott), Antero Resources (**AR.N,** covered by Devin McDermott), Energy Transfer (**ET.N,** covered by Robert Kad), Kinder Morgan (**KMI.N,** covered by Robert Kad), and Williams (**WMB.N,** covered by Robert Kad).

10. We also see increased demand for new nuclear power, especially Small Modular Reactors (SMRs) and large new reactors. In our recent global note on *Nuclear Renaissance*, in our recent *follow-up to this note*, and on *How Do Cloud Hyperscalers Plan to Meet Their Climate Goals?* we highlighted our expectation that hyperscalers such as Amazon, Microsoft and Alphabet would likely pursue new nuclear power project development, which we believe would achieve multiple objectives: **(i)** provides "power additionality," which in turn could improve the prospects of policymaker approval of large new Data Center projects; **(ii)** is consistent with these companies' emissions reduction goals; and **(iii)** provides baseload, high quality, controllable power, which we believe will become increasingly valuable as renewables penetration levels increase around the world. To support the latter point, we include a recent quote from Jensen Huang, CEO of NVIDIA Corp., stating the following: *nuclear power is a "good option for the renewable energy needed for the growing number of data centers*." It is worth noting that it is our view that SMRs will remain a next decade technology, even in light of the demand for "additionality."

11. We're still bullish power prices. The amount of Data Center capacity looking to connect to the grid is much larger than the planned new firm generation in PJM and ERCOT and tightening reserve margins will push up prices in our view to a level that would incentivize new build gas plants — in the $60s/MWh vs. the $50/MWh level currently priced in the forward curve. As incremental load forecasts are released in PJM and ERCOT, and Data Center owners over time start hedging their power, we would expect the forward power curves to react.

Exhibit 11: AI Infrastructure Value Chain

Ticker	Company	Analyst	Sector	Rating	Currency	Share Price
Power Providers						
BE.N	Bloom Energy Corp.	Percoco, Andrew	Industrials	Overweight	USD	27.45
RWEG.DE	RWE AG	Pulleyn, Robert	Utilities	Overweight	EUR	31.83
AES.N	AES Corp.	Arcaro, David	Utilities	Overweight	USD	13.04
ORSTED.CO	Orsted A/S	Pulleyn, Robert	Utilities	Overweight	DKK	381.40
NEE.N	NextEra Energy Inc	Arcaro, David	Utilities	Overweight	USD	78.67
ENGIE.PA	ENGIE	Sitbon, Arthur	Utilities	Overweight	EUR	14.96
SCIL.SI	SembCorp Industries Ltd	Maheshwari, Mayank	Utilities	Overweight	SGD	5.28
TENA.KL	Tenaga Nasional	Maheshwari, Mayank	Utilities	Overweight	MYR	13.48
CEG.O	Constellation Energy Corporation	Arcaro, David	Utilities	Overweight	USD	256.56
TLN.O	Talen	Not Covered	Utilities	Not Covered	Not Covered	Not Covered
GEV.N	GE Vernova	Percoco, Andrew	Industrials	Overweight	USD	334.12
VST.N	Vistra Corp	Arcaro, David	Utilities	Overweight	USD	159.84
NRG.N	NRG Energy Inc	Arcaro, David	Utilities	Equal-Weight	USD	101.61
ATO.N	Atmos Energy Corp.	Arcaro, David	Utilities	Overweight	USD	151.32
AEP.O	American Electric Power Co	Arcaro, David	Utilities	Overweight	USD	99.86
PEG.N	Public Service Enterprise Group Inc	Arcaro, David	Utilities	Overweight	USD	94.30
IBE.MC	Iberdrola SA	Pulleyn, Robert	Utilities	Overweight	EUR	13.51
MGEE.O	MGE Energy, Inc.	Arcaro, David	Utilities	Underweight	USD	104.28
RR.L	Rolls-Royce Holdings PLC	Law, Ross	Industrials	Overweight	GBp	573.00 GBp
ATCOa.ST	Atlas Copco	Yates, Max	Industrials	Underweight	SEK	177.05
ENR1n.DE	Siemens Energy AG	Yates, Max	Industrials	Overweight	EUR	51.50
7011.T	Mitsubishi Heavy Industries	Ibara, Yoshinao	Industrials	Overweight	JPY	2,246.00
000150.KS	Doosan	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
Advanced Cooling						
VRT.O	VRT-US	Vertiv	Industrials	Not Covered	Not Covered	Not Covered
SCHN.PA	Schneider Electric	Yates, Max	Industrials	Equal-Weight	EUR	243.10
2308.TW	Delta Electronics Inc.	Shih, Sharon	Information Technology	Overweight	TWD	388.50
LEGD.PA	Legrand	Yates, Max	Industrials	Overweight	EUR	94.94
3324.TWO	Auras Technology Co Ltd	Shih, Sharon	Information Technology	Equal-Weight	TWD	706.00
2376.TW	Giga-Byte Technology Co. Ltd.	Kao, Howard	Information Technology	Overweight	TWD	273.50
2421.TW	Sunonwealth Electric Machine Industry	Shih, Sharon	Industrials	Equal-Weight	TWD	99.90
3017.TW	Asia Vital Components Co. Ltd.	Shih, Sharon	Information Technology	Overweight	TWD	678.00
2354.TW	Foxconn Technology	Shih, Sharon	Information Technology	Overweight	TWD	79.70
NVT	nVent Electric	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
Power Electronics and Management						
7011.T	Mitsubishi Heavy Industries	Ibara, Yoshinao	Industrials	Overweight	JPY	2,246.00
ETN.N	Eaton Corporation PLC	Snyder, Christopher	Industrials	Overweight	USD	375.42
TT.N	Trane Technologies PLC	Snyder, Christopher	Industrials	Overweight	USD	416.22
SCHN.PA	Schneider Electric	Yates, Max	Industrials	Equal-Weight	EUR	243.10
HON.O	Honeywell International Inc	Snyder, Christopher	Industrials	Equal-Weight	USD	232.93
GNRC.N	Generac Holdings	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
005930.KS	Samsung Electronics	Kim, Shawn	Information Technology	Overweight	KRW	53,600.00
6503.T	Mitsubishi Electric	Ibara, Yoshinao	Industrials	Overweight	JPY	2,568.50
6504.T	Fuji Electric	Terashi, Masatoshi	Industrials	Equal-Weight	JPY	8,692.00
2308.TW	Delta Electronics Inc.	Shih, Sharon	Information Technology	Overweight	TWD	388.50
FLEX	Flex Ltd.	Not Covered	Information Technology	Not Covered	Not Covered	Not Covered
ATCOa.ST	Atlas Copco	Yates, Max	Industrials	Underweight	SEK	177.05
2301.TW	Lite-On Technology	Shih, Sharon	Information Technology	Underweight	TWD	105.50
EMR.N	Emerson	Snyder, Christopher	Industrials	Underweight	USD	132.60
HON.O	Honeywell International Inc	Snyder, Christopher	Industrials	Equal-Weight	USD	232.93
LEGD.PA	Legrand	Yates, Max	Industrials	Overweight	EUR	94.94
VRT.O	Vertiv	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
PRY.MI	Prysmian SpA	Yates, Max	Industrials	Equal-Weight	EUR	63.04
UPS						
ETN.N	Eaton Corporation PLC	Snyder, Christopher	Industrials	Overweight	USD	375.42
LEGD.PA	Legrand	Yates, Max	Industrials	Overweight	EUR	94.94
2308.TW	Delta Electronics Inc.	Shih, Sharon	Information Technology	Overweight	TWD	388.50
VRT.O	Vertiv	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
SCHN.PA	Schneider Electric	Yates, Max	Industrials	Equal-Weight	EUR	243.10
HPE.N	Hewlett Packard Enterprise	Marshall, Meta	Information Technology	Equal-Weight	USD	21.22
6503.T	Mitsubishi Electric	Ibara, Yoshinao	Industrials	Overweight	JPY	2,568.50
6504.T	Fuji Electric	Terashi, Masatoshi	Industrials	Equal-Weight	JPY	8,692.00
Generators						
CMI.N	Cummins Inc	Castillo, Angel	Industrials	Overweight	USD	375.04
CAT.N	Caterpillar Inc	Castillo, Angel	Industrials	Underweight	USD	406.11
AME.N	AMETEK	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
ATCOa.ST	Atlas Copco	Yates, Max	Industrials	Underweight	SEK	177.05
6503.T	Mitsubishi Electric	Ibara, Yoshinao	Industrials	Overweight	JPY	2,568.50
7012.T	Kawasaki Heavy Industries	Terashi, Masatoshi	Industrials	Equal-Weight	JPY	5,588.00
RR.L	Rolls-Royce Holdings PLC	Law, Ross	Industrials	Overweight	GBp	573.00 GBp
7011.T	Mitsubishi Heavy Industries	Ibara, Yoshinao	Industrials	Overweight	JPY	2,246.00
6504.T	Fuji Electric	Terashi, Masatoshi	Industrials	Equal-Weight	JPY	8,692.00
Networking Equipment and Comms. Infrastructure - Fiber, Memory/Storage, Optical.						
000660.KS	SK hynix	Kim, Shawn	Information Technology	Underweight	KRW	158,800.00
FN-US	Fabrinet	Not Covered	Information Technology	Not Covered	Not Covered	Not Covered
ANET.N	Arista Networks	Marshall, Meta	Information Technology	Overweight	USD	405.82
CSCO.O	Cisco Systems Inc	Marshall, Meta	Information Technology	Overweight	USD	59.21
WDC.O	Western Digital	Moore, Joseph	Information Technology	Overweight	USD	72.99
COHR.N	Coherent Corp	Marshall, Meta	Information Technology	Equal-Weight	USD	100.16
LITE.O	Lumentum Holdings Inc	Marshall, Meta	Information Technology	Equal-Weight	USD	86.97
CIEN.N	Ciena Corporation	Marshall, Meta	Information Technology	Equal-Weight	USD	69.72
JNPR.N	Juniper Networks Inc	Marshall, Meta	Information Technology	Equal-Weight	USD	35.92
IRM-US	Iron Mountain	Not Covered	Real Estate	Not Covered	Not Covered	Not Covered
HPE.N	Hewlett Packard Enterprise	Marshall, Meta	Information Technology	Equal-Weight	USD	21.22
PSTG.N	Pure Storage Inc	Marshall, Meta	Information Technology	Equal-Weight	USD	52.99
300308.SZ	Zhongji Innolight Co Ltd	Meng, Andy	Information Technology	Overweight	CNY	132.03
2345.TW	Accton Technology Corporation	Yang, Derrick	Information Technology	Overweight	TWD	704.00
INFN.O	Infinera Corp	Marshall, Meta	Information Technology	Equal-Weight	USD	6.61
300502.SZ	Eoptolink Technology Inc Ltd	Meng, Andy	Information Technology	Equal-Weight	CNY	120.71
3231.TW	Wistron Corporation	Kao, Howard	Information Technology	Overweight	TWD	114.00
688008.SS	Montage Technology Co Ltd	Yen, Daniel	Information Technology	Overweight	CNY	69.13
0992.HK	Lenovo	Kao, Howard	Information Technology	++	HKD	9.11 HKD
3110.T	Nitto Boseki	Hasegawa, Yoshihito	Industrials	Overweight	JPY	5,840.00
6871.T	Micronics Japan	Hasegawa, Yoshihito	Information Technology	Overweight	JPY	3,805.00
6723.T	Renesas Electronics	Yoshikawa, Kazuo	Information Technology	Overweight	JPY	2,017.50
8299.TWO	Phison Electronics Corp	Chan, Charlie	Information Technology	Equal-Weight	TWD	468.00
Power Equipment (Transmission Equipment)						
LEGD.PA	Legrand	Yates, Max	Industrials	Overweight	EUR	94.94
ABBN.S	ABB	Yates, Max	Industrials	Underweight	CHF	51.02 CHF
SCHN.PA	Schneider Electric	Yates, Max	Industrials	Equal-Weight	EUR	243.10
ENR1n.DE	Siemens Energy AG	Yates, Max	Industrials	Overweight	EUR	51.50
PRY.MI	Prysmian SpA	Yates, Max	Industrials	Equal-Weight	EUR	63.04
GEV.N	GE Vernova	Percoco, Andrew	Industrials	Overweight	USD	334.12
6501.T	Hitachi	Terashi, Masatoshi	Industrials	Equal-Weight	JPY	3,946.00
Nat Gas Suppliers						
EQT.N	EQT Corp.	McDermott, Devin	Energy	Overweight	USD	45.44
AR.N	Antero Resources Corp	McDermott, Devin	Energy	Overweight	USD	32.69
ET.N	Energy Transfer LP	Kad, Robert	Energy	Overweight	USD	19.86
KMI.N	Kinder Morgan Inc.	Kad, Robert	Energy	Equal-Weight	USD	28.27
WMB.N	Williams Companies Inc	Kad, Robert	Energy	Overweight	USD	58.52
NRG.N	NRG Energy Inc	Arcaro, David	Utilities	Equal-Weight	USD	101.61
Other - Construction Services/Design, Developers and Operators, etc.						
5274.TWO	Aspeed Technology	Yen, Daniel	Information Technology	Equal-Weight	TWD	4,050.00
SGEF.PA	Vinci SA	Mora, Nicolas	Industrials	Overweight	EUR	97.26
ACMR.O	ACM Research Inc	Chan, Charlie	Information Technology	Overweight	USD	17.19
MTZ.N	Mastec	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
PLD.N	Prologis, Inc.	Kamdem, Ronald	Real Estate	Overweight	USD	116.78
DLR.N	Digital Realty Trust Inc.	Flannery, Simon	Real Estate	Equal-Weight	USD	195.69
9613.T	NTT DATA	Tanaka, Hideaki	Information Technology	Overweight	JPY	2,879.50
EQIX.O	Equinix Inc.	Flannery, Simon	Real Estate	Equal-Weight	USD	981.48
DBRG-US	Digital Bridge	Not Covered	Real Estate	Not Covered	Not Covered	Not Covered
SFR.AX	Sandfire Resources Ltd	Anand, Rahul	Materials	Equal-Weight	AUD	10.49 AUD
RWAY.MI	Rai Way SpA	Kelly, Emmet	Communication Services	Equal-Weight	EUR	5.15
TELIA.ST	Telia Company AB	Tsui, Terence	Communication Services	Equal-Weight	SEK	31.80
601138.SS	Foxconn Industrial Internet Co. Ltd.	Shih, Sharon	Information Technology	Overweight	CNY	22.56
ACM-US	AECOM	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
PWR	Quanta Services	Not Covered	Industrials	Not Covered	Not Covered	Not Covered
TRMB	Trimble	Not Covered	N/A	Not Covered	Not Covered	Not Covered
BX.N	Blackstone Inc.	Cyprys, Michael	Financials	Overweight	USD	191.09

Source: Morgan Stanley Research. Data as of market close 11/29/2024. ++ Stock Rating, Price Target, or Estimates for this company have been removed from consideration in this report because, under applicable law and/or Morgan Stanley policy, Morgan Stanley may be precluded from issuing such information with respect to this company at this time.

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(as of November 30, 2024)

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	Coverage Universe		Investment Banking Clients (IBC)			Other Material Investment Services Clients (MISC)	
Stock Rating Category	Count	% of Total	Count	% of Total IBC	% of Rating Category	Count	% of Total Other MISC
Overweight/Buy	1420	38%	356	45%	25%	646	38%
Equal-weight/Hold	1731	46%	367	46%	21%	819	48%
Not-Rated/Hold	5	0%	0	0%	0%	1	0%
Underweight/Sell	593	16%	73	9%	12%	228	13%
Total	3,749		796			1694	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

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Overweight (O or Over) - The stock's total return is expected to exceed the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis over the next 12-18 months.

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Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

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Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.

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Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index or MSCI sub-regional index or MSCI AC Asia Pacific ex Japan Index.

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