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Without ample investments in data centers and power infrastructure, the potential of AI will not be fully realized. This article addresses this rapidly evolving space: the prospective growth of AI and demand for data centers, the challenges to scaling data centers, and how investors and incumbents could realize significant gains while helping fulfill AI"s potential.

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Depending on the workload, data centers can draw power around the clock, with some intraday variation, much like other industrial centers. However, data centers present a unique profile that differentiates them for utility companies and investors.

First, most data centers are sited with backup energy storage systems to ensure high uptime requirements are met. This backup can be dispatched to offset a data center"s load when grid conditions become tight, thus creating a load that is, in effect, highly responsive.

Second, data center owners typically have a higher willingness than most other power customers to pay for power. Electricity operating expenditures make up about 20 percent of the total cost base for data center business models, which have proved to be highly profitable for large companies. Therefore, higher power rates do not disrupt the business model. In comparison, for other electricity sources, such as green-hydrogen production, the final product cost is highly dependent on electricity prices, and the expected margins are much thinner.

In locations with access to power on the bulk transmission grid, there are further constraints on power equipment, such as transformers, on-site backup generators, and power distribution units (PDUs), with historically high lead times of nearly two years in some cases (Exhibit 2).

The strained labor force is an additional inhibitor, particularly the emerging shortage of electrical trade workers essential to executing these projects. McKinsey estimates anticipate a potential shortage of up to

400,000 trade workers in the United States based on projected data center build-out and comparable assets requiring similar skills, such as semiconductor fabrication and battery gigafactories.6"Generative AI and the future of work in America," McKinsey Global Institute, July 26, 2023.

Additionally, the industry faces the daunting challenge of decarbonizing its footprint to achieve the goal of 24/7 carbon-free energy usage by 2030. While the carbon emission intensity for power grids is set to drop in the next ten years,7"Emissions of carbon dioxide in the electric power sector," Congressional Budget Office, December 13, 2022. generation from natural gas nationally is expected to increase (Exhibit 3). At the same time, most grid decarbonization timelines (if they exist) far exceed the targets set by major hyperscalers.

Across the power value chain, investors can participate in and enable solutions to meet the demand for data centers and accelerate growth. Current progress and limitations alike illuminate three clear areas in which investors may be able to make the most impact: power access and sources, power equipment, and trades and technicians.

In recent decades, new nuclear builds have faced difficulties in the United States and other developed markets. Delays and cost overruns have resulted in poor economics for ratepayers, while costs of other forms of power generation have declined. But with the potentially tremendous growth of compute demand in the coming decades, interest in nuclear power could be renewed. Nuclear power offers several advantages for both the power and compute sectors:

For nuclear to play a role in the generative AI revolution, investment in the sector to scale would need to be significant, but the payoff could be worthwhile, especially as load continues to grow. Demand could increase by 75 percent by 2040, reaching 6,908 terawatt-hours.