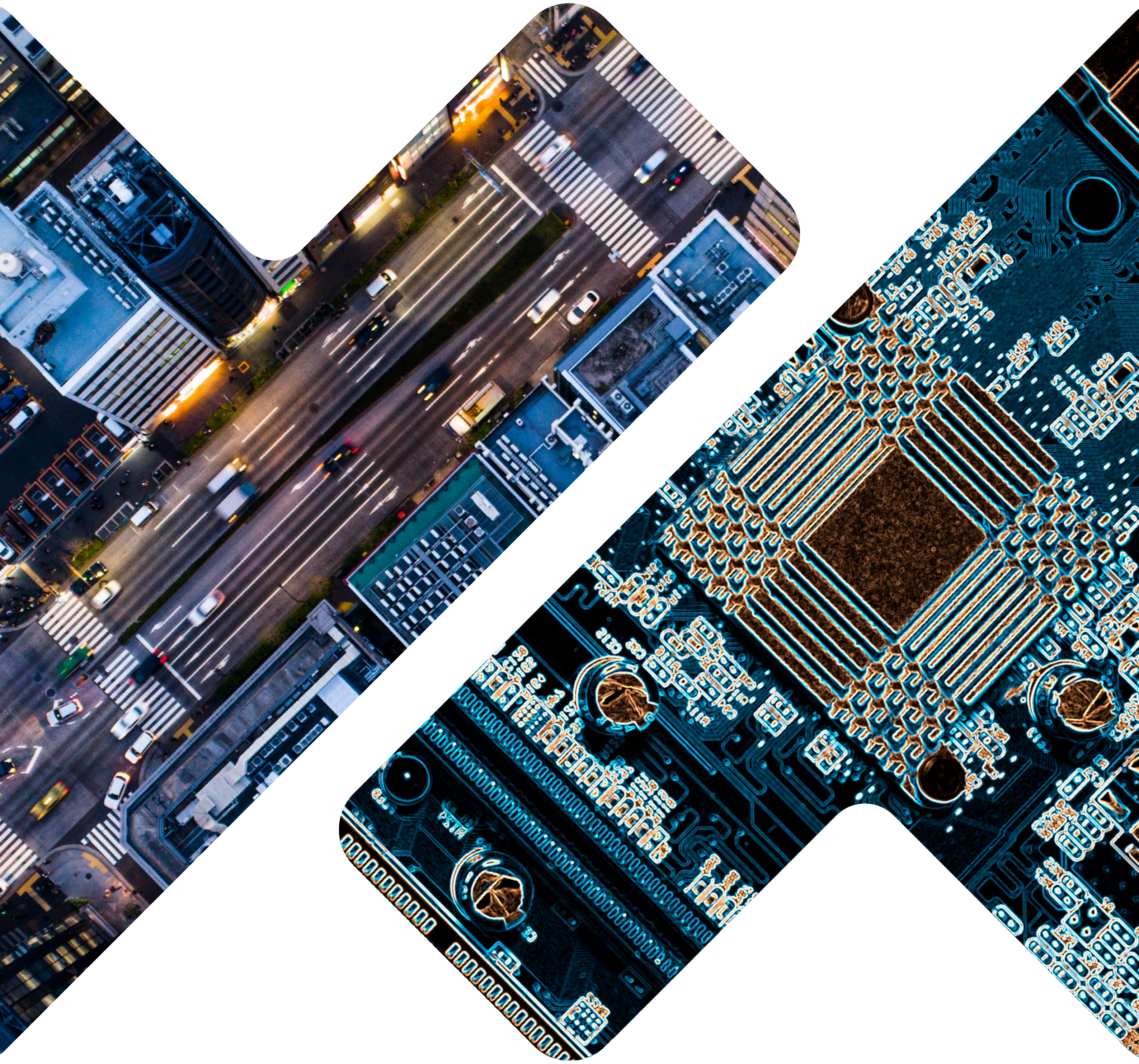

HORIZONS

US power struggle
How data centre demand is challenging the electricity market model

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US utilities have been caught flat-footed as a surge in the development of power-hungry data centres and manufacturing facilities has packed load interconnection queues. As we wrote in last October's Horizons, this has left the power sector with a demand growth dilemma. And the challenge has only intensified.

There are substantial hurdles to meeting such gargantuan demand growth: procurement bottlenecks for critical supply-side equipment, the retirement of substantial amounts of coal-fired generation, tariff and energy policy changes that make renewables development more challenging, long lead times on new projects and the need for transmission upgrades.

Since October, the long load queues have grown even longer. Wait times for grid connection have increased. Developers and data centre owners were hoping they could find off-grid solutions to circumvent delays only to come up against technical issues.

It is increasingly clear that some vertically integrated regulated utilities are best placed to supply the new demand. Areas with retail choice that rely on competitive power markets to meet demand growth are finding it harder.

If data centres are added faster than new power plants can be brought online, it could threaten grid reliability and lead to power outages

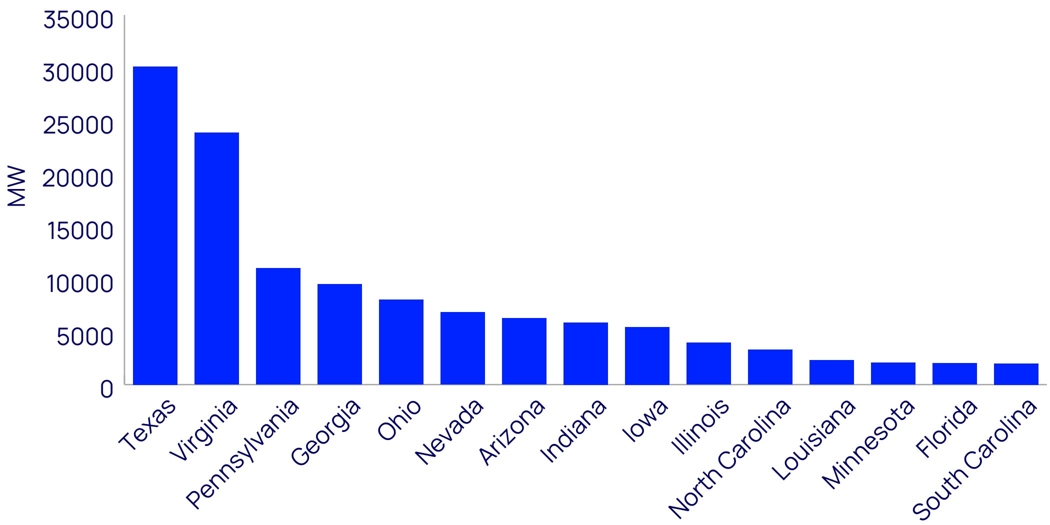
These issues are of paramount importance. The large-load demand being met by regulated utilities is raising a host of new issues for regulators and could leave existing customers picking up the tab for data centre power investments, should demand not materialise as anticipated. In some cases, just a few major customers will soon account for as much utility infrastructure investment as all other customers put together, reshaping utilities' risk profile. In a competitive power market, if data centres are added faster than new power plants can be brought online, it could threaten grid reliability and lead to power outages.

A proliferation of data centres

The biggest challenge for the power industry is predicting the future scale of data centre electricity demand. In a fundamental mismatch, the tech companies fuelling the surge only have demand visibility for three to five years, whereas energy-sector investors take a 30-year view. Moreover, the profitability of new investments in artificial intelligence (AI) services, in particular, is unknown. As tech companies gain greater understanding of the AI profit outlook, there could be big upward or downward shifts in their needs.

Wood Mackenzie is now tracking 134 GW of proposed data centres across the US, up from 50 GW a year ago. Grid operators have received interconnection requests far exceeding this, as some developers have bagged spots in multiple queues, hoping one of them will pay off, while others have yet to disclose project details. As the ability to secure interconnection and energy supply becomes the biggest constraint on data centre developers, proposed project locations are extending beyond traditional markets into states such as Pennsylvania, Ohio, Indiana and Iowa, where large-scale data centre construction is a new phenomenon.

Figure 1:
MW of data centres announced since 1 January 2023 in top 15 US states



Source: Wood Mackenzie

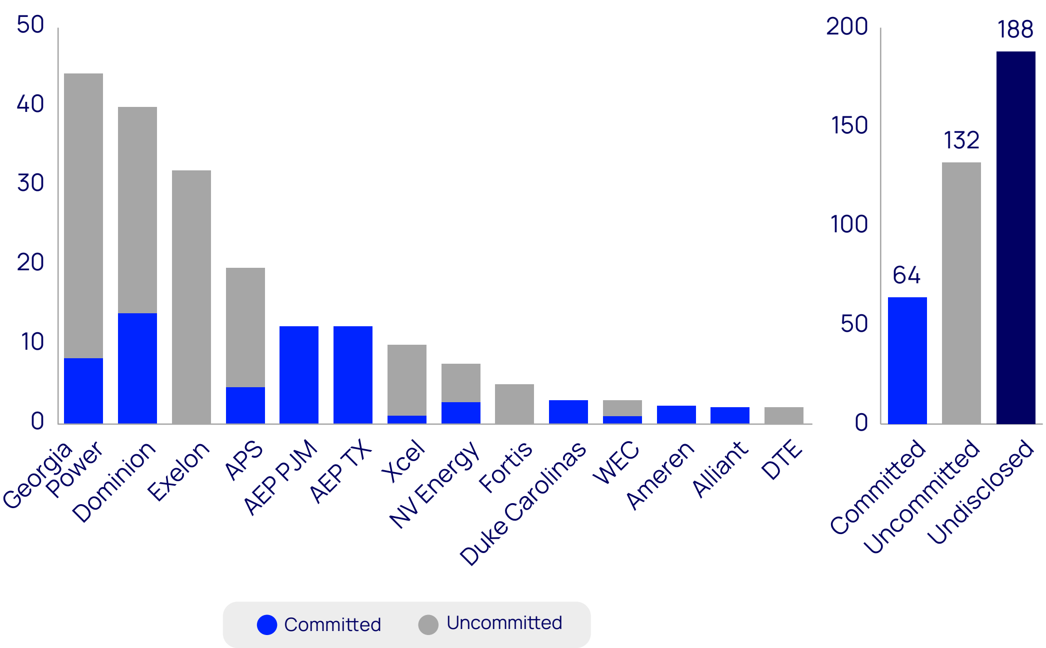
Public commitments a useful indicator

A number of US utilities have publicly reported how much data centre capacity they have signed up to serve – and this is the strongest indicator we have of the scale of coming demand growth (See Figure 2). To date, these utilities have committed to supplying 64 GW of new data centre capacity, equal to a 12% increase in current US electricity demand.

These utilities have an additional 132 GW in their large-load interconnection queues to which they or the developer have not yet committed. Another five utilities not included in the following chart have not disclosed their commitments but have indicated that they have 188 GW in their queues. Much of this capacity is with Oncor in Texas.

Most of the utilities that have reported commitments are in states that lack retail choice, meaning that a utility committing to serve such a load must ensure it has adequate power supply and transmission to do so. Among the utilities that have reported commitments to serve data centres, Exelon and AEP-TX cannot own generation, and so have committed only to making the transmission upgrades required to accommodate the large load. It is up to the competitive market to ensure there is generation supply to meet the load.

Figure 2: Large-load queue capacity by utility commitment status, for individual utilities (left) and summed over tracked utilities (right) (GW)



Source: Wood Mackenzie

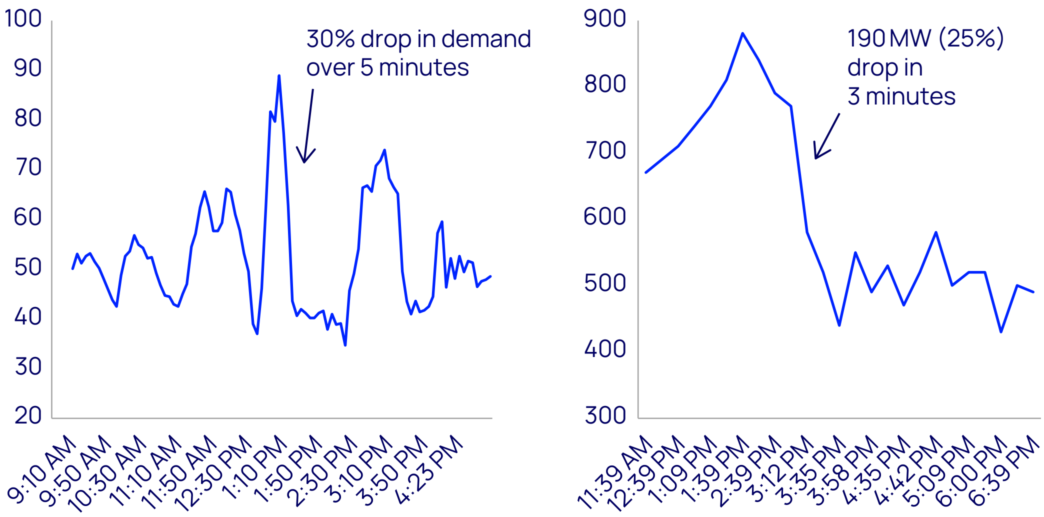
Off-grid solutions are much touted, but rare

With interconnection being the main choke point for new data centres, industry attention has focused on developing off-grid solutions. These are self-sufficient power systems – directly connected power plants or renewable resources – that operate independently of the main electrical grid. Some projects aim to be 'bridge solutions' until a grid interconnection is established, and some are intended as long-term solutions. But while there is much industry chatter about such off-grid solutions, they are extremely rare in our project tracking.

Relying on resources with no grid connection introduces enormous engineering complexity and risk

Off-grid projects face one key obstacle. Data centre firms are good at building facilities that serve their computing needs and consume a large amount of power. Their demand can vary from minute to minute, however, and a grid is better suited than most other options to dealing with such fluctuating demand. Relying on resources with no grid connection introduces enormous engineering complexity and risk, for which data centre companies have limited appetite.

Figure 3: Real-time power consumption from two US hyperscale data centres (MW)



Source: Wood Mackenzie PowerRT Sensor Data

There are multiple obstacles beyond the engineering complexity and cost of meeting minute-to-minute fluctuating demand. A key one is getting companies to align on commercial terms: developers typically want a 20- to 30-year commitment to undertake such projects, but data centre developers tend to think in terms of much shorter timeframes. Having adequate land for data centre development and generation is another, as is securing air permits that allow onsite generators to run a sufficient number of hours to provide the needed level of reliability.

Despite these obstacles, a few developers continue to work on off-grid solutions. One example is AEP's use of natural gas fuel cells combined with ultracapacitors, intended to serve as a bridge solution until it can connect the data centre to the grid.

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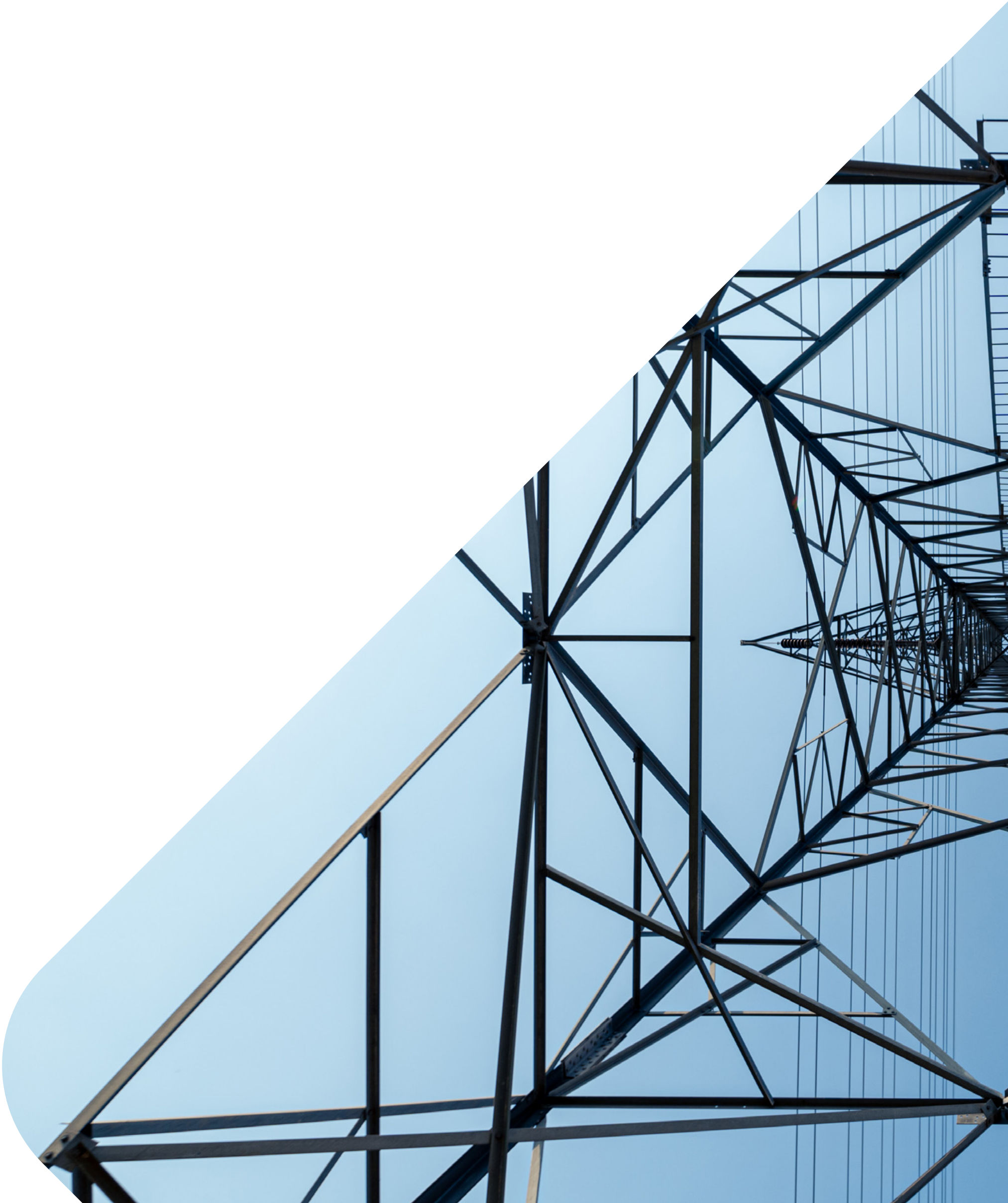

Regulated utilities best placed to meet demand growth

With off-grid unlikely to be a viable, scalable solution, it is increasingly clear that vertically integrated regulated utilities that embrace data centres are the likely leaders in capturing the growth opportunity. They can capitalise on the following strengths:

- **Integrated load and generation planning processes.** Thanks to their integrated planning processes, regulated utilities are in the best position to plan for new demand growth. A data centre developer knows that when it has a utility's commitment for an interconnection, it will be able to secure power supply.
- **Flexibility and creativity in accelerating project timelines.** Utilities are not known for innovation, but because of their integrated planning processes, they are best placed to advise data centre developers on how to shorten development timelines. Among the critical factors that can accelerate projects are allowing interruptibility, alternative project sizing, utilising grid enhancing technologies, differing ramp schedules, creative power contracts or other out-of-the-box options. They can also advise the data centre on where it should connect.
- **Building local buy-in.** Utilities' political relationships can be helpful in gaining local support for data centre development and paving the way for zoning or regulatory changes. One data centre firm told us they look for energy suppliers that will "foster political and public alignment around data centres" and "enable data centres in site development plans and zoning".
- **Land ownership at attractive sites.** Multiple utilities that have retired coal-fired power plants or other economic development sites have realised that they own land with significant transmission and fibre infrastructure, where data centres could be developed.

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Utilities' embrace of large loads vary dramatically

Utilities' embrace of large loads vary dramatically. Many see them as an opportunity to expand their rate base, to improve existing infrastructure utilisation and to support local economic development. Some, however, want nothing to do with large-load growth. In some cases, regulatory rules mean data centres offer utilities few benefits. Others are struggling to get workers to embrace innovative interconnection processes or to move at the kind of speed preferred by data centre developers.

Still, a few utilities are emerging as winners as they gain commitments to sign data centres and expand their growth opportunities. Several say data centres have enabled them to increase asset utilisation and reduce costs for existing customers – although there are limits to these benefits, as further demand growth will require considerable new investment. One utility has a unique tariff structure whereby, if it is able to charge a large-load customer more than the cost of serving it, it shares a portion of the profit with customers, while the remainder enables it to earn more than its regulated return on equity.

Not every utility is a winner, however. While some of the utilities we talked to want to build new generation capacity themselves and increase their rate base, others do not have the balance-sheet scope to do so, may have unique regulatory rules that result in new load not providing much benefit, or face regulatory processes that require competitive power providers to meet the new demand. This will create opportunity for competitive power providers to negotiate new power purchase agreements with utilities or to sell their development sites to utilities.

Reshaping the utility risk profile and business model

Since the inception of the regulated electric utility industry in the US a century ago, utilities have served and recovered costs from a vast group of customers based largely on the average cost of service. Typically, if a new customer group requires new infrastructure, its cost has largely been spread across new and existing customers. Large-load customers are challenging this regulatory model.

In some cases, a few very large customers will soon account for as much utility investment in infrastructure as all other customers put together, reshaping utilities' risk profile. There is asymmetry between the utilities' long-term investment to serve one class of customer in an industry that has historically been very volatile and experienced rapid technological change. What happens if tech company demand does not grow as forecast, because its needs change or it becomes more power-efficient? This raises the issue of how to develop new regulatory mechanisms that ensure these new customers pay for the costs of serving them – and how to protect other customers and utility shareholders if data centre electricity demand drops or never materialises as forecast.

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Utilities have moved to rectify this by developing special tariffs for large-load customers, aimed at isolating their cost recovery and stranded asset risk. We recently undertook a comparative analysis of large-load tariffs developed by utilities. Typical terms include:

- rates based on the marginal cost of serving the customer
- a minimum number of years for which a customer is obliged to pay for service, whether or not they take power, with an option to pay an exit fee
- minimum monthly demand and energy charges, even if the customer does not purchase that level of power
- collateral requirements.

Such rate schedules are proving contentious, however, with two particularly thorny issues. The first is ensuring that all marginal costs are reflected in the rate. Transmission costs, for instance, are often recovered through long-standing allocation methodologies that recover costs from all types of customer across all utilities in a region. These are developed through interregional processes, not by the state public utility commission.

The second is the length of commitment to purchase power. Only in very few cases are the large-load customers required to purchase power for a period and at a rate that covers the cost of the new investments. For instance, few large-load tariffs have contract lengths longer than 15 years and many are much shorter. Debates are likely to ensue at public utility commission hearings on the right balance between length of commitment, the rates needed to recover the investment cost and the outstanding investment remaining to be recovered at the end of the tariff term, set against the new infrastructure's value at that time.

There is a way to mitigate this risk. Removing new large-load generation investment from a utility's books guarantees protection for existing customers and shareholders. The clean transition tariffs developed by certain utilities offer a potential template. These enable large-load customers to offtake clean energy from third parties through the utility. Of course, utilities that want to capitalise financially on large-load growth by building new generation are likely to put up some resistance.

Removing new large-load generation investment from a utility's books guarantees protection for existing customers and shareholders

Testing the “invisible hand” of the deregulated power market

In markets with vertically integrated utilities, the utility commits to serve a new load only when it can ensure it has the power supply to do so reliably. In deregulated markets with retail choice, it is a different story.

The regulated, wires-only utility studies the large-load interconnection request to identify what transmission upgrades are required to safely serve that load. The regional grid operator identifies what transmission is needed across the system to serve it. No study is conducted to determine whether there is adequate generation to meet the new customer’s needs. It falls to the deregulated power market to ensure that the load is served.

The dilemma is that new demand in the form of data centres can be added to the grid far more quickly than new generation supply. And there is nothing, other than Adam Smith’s “invisible hand of the market”, to ensure that future supply will meet today’s demand commitments.

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Currently, there is no sign that the invisible hand is doing its job well. In Texas, for instance, after developing a process to determine what growth in load is likely to materialise, ERCOT is planning to build out the grid to accommodate more than 60% new demand growth (50 GW) by 2030, while the wires utilities are building out interconnections. Despite predictions by the North American Electricity Reliability Corporation (NERC) of elevated resource adequacy risk and the need for massive amounts of new generation to meet this growth, ERCOT forward prices remain below the level necessary to incentivise new entry. Several developers have recently cancelled plans to build new gas-fired generation in the region, despite special financing incentives.

PJM, the operator of the grid in the US Mid-Atlantic region, meanwhile, relies on a forward-looking capacity market to secure commitments from power suppliers to meet future electricity demand. In the most recent capacity market auction, prices increased almost tenfold from the prior auction. This sparked political outcry, prompting the establishment of a price floor (US$175 per MW-day) and ceiling (US$325 per MW-day) for the next auction. Alas, this price floor comes as the costs of building new gas-fired plants have almost doubled since Covid to US$2,100 to US$2,400 per kW. Prices of anywhere from 30% to 200% higher than the price cap are likely to be required to attract new investment to meet demand growth. The invisible hand does not function well when price caps are below the costs required to attract new investment.

There is one more important difference between competitive power markets with retail choice and vertically integrated regulated utilities. In regulated markets, it is easier, through regulation, to allocate the increased investment costs needed to serve large loads directly. In deregulated markets, which rely on the wholesale power market to match supply and demand, it is the price of wholesale power that provides the signal for new investment. If higher prices are required to incentivise that investment, all customers will face higher prices.

In electricity, a very localised market in which politicians can be blamed for lofty rates, there is much more likely to be political outcry

While this is the way efficient markets work for all commodities, in electricity, a very localised market in which politicians can be blamed for lofty rates, there is much more likely to be political outcry as a result of large-load demand growth.

Situation critical

Something will have to give. Regulatory intervention or a new set of rules are likely to emerge from what could become a growing crisis. Some states may intervene to prevent data centres from co-locating with existing power generation plants. Others may mandate utilities currently out of the generation business to get back in the game in a rate-regulated manner, or establish a mandate to purchase power from new resources on an expedited basis through long-term power purchase agreements. Alternatively, we could see moratoria on new large loads or stricter study processes for additional loads. Waiting for a power-outage crisis to spark policy and regulatory change would be a worst-case scenario.

It is important to be aware of these possibilities and think through their implications. They could have far-reaching consequences for development opportunities, while regulatory interventions that affect power prices are likely to influence asset valuations for those looking to acquire existing resources.

Something will have to give

The situation also calls for a closer look at how the demand-side flexibility that market designers originally envisioned could finally be brought to bear in a more material way. This could take multiple forms. Utility tariffs are beginning to impose interruptibility terms on large-load customers – a trend that is likely to continue. Commercial demand response, meanwhile, is becoming increasingly automated, enabling customers to respond to elevated prices and not just emergencies. Data centres have long participated in demand response by way of their backup generators, but only air-cooling load – around 3% of the total – is available today for economic load shifting. Greater focus on these areas could help relieve some of the pressure on the system.

Conclusion: Utilities must 'build the plane while flying it'

The US power industry is navigating a critical crossroads. National security and economic development imperatives require new power supplies to power AI data centres and advanced manufacturing. However, the scale of this new demand exceeds the industry's supply capacity, and few measures are in place to prevent the erosion of grid reliability, particularly in regions that lack vertically integrated regulated utilities.

This challenge presents an unprecedented test of deregulated power markets, which must plan grid development and ensure appropriate price signals amid tremendous market and policy uncertainty. If markets fail this test, they will become increasingly hobbled by states seeking to take reliability and cost recovery into their own hands.

Utilities are very exposed, seeking to balance state economic development objectives and an unprecedented revenue opportunity against the risk to reliability and a new credit profile. As one utility executive observed, they are building the plane while flying it. The route may be uncharted, but one thing is certain: utilities' business models will have to evolve and their financial situation may look very different when they are done.

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