**Goldman Sachs Exchanges**

**AI Exchanges: Where Will the Power Come From?**

**Rebecca Kruger, Partner, Natural Resources Group in Investment Banking, Goldman Sachs**

**George Lee, Co-Head, Goldman Sachs Institute, Goldman Sachs**

**Allison Nathan, Senior Strategist, Goldman Sachs Research**

**Date of Recording: July 9, 2025**

**Allison Nathan:** Welcome to Goldman Sachs Exchanges. I'm Allison Nathan, and I'm here with George Lee, the co-head of our Goldman Sachs Global Institute. Together we're co-hosting a series of episodes exploring the rise of AI and everything it could mean for companies, investors, and economies. George, good to see you again.

**George Lee:** Great to be here, Allison.

**Allison Nathan:** George, I'm very excited for this conversation because today we're going to discuss one of the biggest questions about the rise of AI: Where will the power come from? We know that it consumes enormous amounts of power; that's come up in a lot of our conversations. And in the first episode of this series, I think you said it may be one of the biggest constraints to the growth and development of AI. So let's dig deeper into that. Tell us why that is.

**George Lee:** There's a temptation to think about AI as this sort of ephemeral phenomenon, the great chatbot in the sky. The reality is this is one of the most physical technology infrastructures ever built. Vast data centers filled with racks of servers and GPUs and other gear. All of that gear requires enormous amount of power and at a scale and density that probably has never been seen in the history of computation before.

That coming at the same time of a bunch of other emergent power needs in the world has really made power kind of perhaps the most binding constraint or bottleneck on the delivery of the promises of AI. And probably more interesting, it brings together two very orthogonal populations in our commercial ecosystem -- hyperscalers and the fastest-moving, most innovative technology companies in the world and highly regulated utilities. And our guest, Rebecca Kruger, stands at the very nexus of those two populations. So, it'll be fascinating to have this discussion with her.

**Allison Nathan:** So, let's bring Rebecca into the conversation. Rebecca is a partner in our Natural Resources Group within our Investment Banking division, which just published a report entitled "Powering the AI Era." Rebecca, welcome.

**Rebecca Kruger:** Thank you. Thrilled to be here.

**Allison Nathan:** So Rebecca, in your job, you are talking to leaders in this space, corporate leaders in this space, all the time. How is AI dominating those conversations at this point?

**Rebecca Kruger:** It's been top of the list. To say that AI and the associated power demand has been a focus for our clients is a true understatement. And by the way, the CEOs and the boards of our biggest power companies, they will tell you both privately and publicly the power demand that they're seeing is unprecedented, and there's no playbook for this.

But to understand why that is -- because it seems pretty simple, right? AI data centers are getting built, let's just build some power plants. It's actually not that simple. There's a lot that's going into it. So just to set the table for a sec on how did we get here, right? So in the last 20 years in the US, power demand has been flat. And that's despite a growing economy, despite growing population, we all have more devices that we're plugging in. But offsetting all of that has been offshoring, so we've been shutting down a lot of manufacturing plants in the US. That's obviously changing as we try and reshore a lot of manufacturing capacity. And then number two, appliances just got a lot more efficient.

And so during those 20 years of when electricity demand was totally flat, a lot of things calcified on that assumption. It was taken for granted that would always be the case. And so energy policy, for example, started to prioritize low-emission sources of generation. That's a really good thing. Decarbonizing our economy is a great thing to do.

However, intermittent emission-free generation sources like wind and solar are not available all the time. And we're not quite there yet on technology of long-duration storage. And so as a result of energy policy, which has really been prioritizing decarbonization, our grid has been getting less reliable.  Fewer power plants that can operate 24/7, which is what data centers obviously need, and more power sources that are what we call intermittent.

Even before the AI demand story started taking off, participants in the industry were already getting nervous about reliability of the grid.  And EV charging was viewed as the straw that was going to break the camel's back because of all the electricity demand that was going to bring, and the grid just wasn't ready.  The AI demand story is just a step-change in the amount of demand.  And so we can get into it in more detail, but the process of getting more megawatts from more power plants online and serving this load is a really complicated issue.

**Allison Nathan:** And the infrastructure, by the way, is quite old at this point as well.

**Rebecca Kruger:** Yeah, that's right.  Not only are our power plants in the US quite old, the grid, the actual wires that get electrons from where they're produced to where they're consumed, is on average 40-plus years old and not getting any younger.  And the permitting to build new transmission lines is quite time-consuming.

**Allison Nathan:** So how are companies going to meet this increased demand?  What is the plan?

**Rebecca Kruger:** So like everything in energy land, there is no one-size-fits-all solution.  And so we've seen some really interesting partnerships pop up between tech companies and power companies to get more megawatts or more power plants online.  So let me give you some examples of that.

There are nuclear plants, which amazingly enough, were totally uneconomic and out of the money just a few years ago.  They were highly subsidized a couple years ago.  Nuclear plants are exactly what data centers need.  It's clean, firm, power, 24/7 power.  And so you're seeing the hyperscalers partner with some of the owners of these nuclear plants to bring some of them back online.  Three Mile Island.  It was a recent headline there.

Another option at nuclear sites is there's usually excess land there, and so there's something called uprates.  So building more megawatts at an existing nuclear site. So those are some of the low-hanging fruit in the sector. You can probably count on one or two hands the number of opportunities that I just described that are out there.

There's a lot happening on new construction, but there's a timing mismatch. It takes one to two years to get one of these data centers online. It can take -- and I hate to say it -- five, ten years plus to get some of this power generation online. The current administration's doing a lot to try and speed that up -- the permitting and the siting and all of that. And they're having some success in that, which is great. But it's not just that. It's the supply chain to build out some of these assets is quite backed up. A gas combustion turbine, to build a new gas-fired power plant, they're sold out until 2030. And so that is what's driving the bottleneck when we say that power is the biggest constraint on data center build-out.

**George Lee:** Fascinating. Let's double-click on that sort of cadence mismatch between the fast-moving hyperscalers, people who want to produce this AI computation, and the way that utilities are run, governed, and are subject to the gravity of those very real supply chain constraints. How do you see them navigating that mismatch culturally and temporally?

**Rebecca Kruger:** It's been so interesting. So George, you hit this in the intro, which is these two industries which historically have not had to really interact or work together in a major way, they have two completely different approaches to how they attack their problems. One is move fast and break things. The other is do no harm, and I operate under a 30-year planning cycle and my only job is to deliver safe and affordable power.

But it's been really fascinating watching these two industries come together to solve each other's problems. And so we can talk more about some of the partnerships that we're seeing there, but the other really exciting thing that's happening is, during those 20 years of flat power demand, there wasn't a lot of price signals or incentives for anyone really to invest in R&D to develop new technologies or to rethink how we produce and consume energy in this country. That's changing really rapidly, and some of the biggest proponents and funders of it are the hyperscalers.

And so one of the examples that I think is most exciting is this concept called peak shaving or making load more flexible.  And the grid in the US is built for peak demand. So that one hour in August in Texas when everyone's got their AC on, that peak demand is what the grid is built for because the AC's need to go on, the lights need to go on when people flip the switch.  But for so much of the year there's a lot of unused capacity, and so on the one hand, there's headlines out there saying, like, all the lights are going to go out because AI is going to gobble up all the power.  It's much more nuanced because there are all these unused megawatts that don't get used for most of the year. And so some of these new technologies or innovations are going to help data centers become flexible demand centers.

**George Lee:** Yeah, and we've done a lot of work together on this topic, and it implies not only, you know, changes in demand management on your side of the equation but, for the hyperscalers and producers of AI computation, re-instrumenting their algorithms to be able to deal with that intermittency.  And we think there's a lot we -- I think mutually believe there's a lot of headroom there for sure.

The other thing that's very differentiated between the two populations of companies is the quantum of capital available and the way they think about it. These are expensive projects. Talk about how the two populations are coming together to find joint solutions to capital numbers that would have seemed unimaginable years ago to your clients.

**Rebecca Kruger:** Well, and these capital projects, a few years ago these numbers would have been unimaginable. But we're talking overall projects, the data center plus the power, into the tens of billions of dollars. And what's so fascinating about it is power is just a small fraction of the overall cost of the data center build-out. We're talking maybe 10% of the total cost. But as people who follow the power sector know, the average size of a power company is a small fraction of the size of hyperscalers.

And so there's definitely a difference in terms of size and amount of resources, but in some ways it's a great fit. It's like these two puzzle pieces coming together where they both want the infrastructure built. The power companies ultimately want to own it and operate it. It's what they're great at. It's what they're here to do. They have stretch balance sheets, right? These projects and the amount of power they're being asked to build, in some cases doubling what they currently have operating. I mean, that's mind blowing right? When you think about the fact that it took each of these power companies or utilities 50, 100 years to build up what they have today, they're being asked to double that in the next ten years, so it's stunning when you think about it.

On the other hand, the hyperscalers, they have vast financial resources. And so there's a lot of interesting negotiations and partnerships being discussed and negotiated in real time on how can the hyperscalers use their balance sheets and their financial resources to help get some of these assets built.

**George Lee:** Do we have a generation problem or a transmission problem or both?

**Rebecca Kruger:** Yes.

**George Lee:** Right. I thought that might be the answer.

**Rebecca Kruger:** Yeah, I mean, power is a very local or regional industry. It's largely consumed close to where it's produced because there's a lot of what we call line loss as you transmit electrons from where it's generated to where it's ultimately used. And so number one, the concept of siting the user of electricity close to the power plant, it's just more efficient. And in fact, you're seeing what we call more "behind the meter" generation solutions. So data centers literally siting behind the fence, their data centers right next door to the power plant, right? So we're seeing some of that.

That said, we also have some generation assets in pockets of the country that are underutilized today. And so to the extent we can build some new lines to get those electrons from where they're currently underutilized to some load center, that can also help in a really big way because, again I said it earlier, there's no one-size-fits-all solution here. It's going to be both. More megawatts and more transmission.

**George Lee:** So you talked "behind the meter," "inside the fence" scenarios. You also illustrated the challenge of asking companies that have been around for

100 years to double their capacity in a matter of years. To what extent do the big tech companies and hyperscalers take matters into their own hands and vertically integrate and build capacity themselves, co-located with big facilities, particularly in an era where we may see hopefully see things like small modular nuclear or nuclear fusion? Do you think that'll ensue?

**Rebecca Kruger:** So it's possible. It's been interesting watching the journey on the tech side as they started getting very smart -- and this is not recent, this has been a journey they've been on for many years. But they've reached a point where they are so sophisticated on energy, and they are very effective advocates in DC on energy policy because, you know, as mentioned, it's their biggest bottleneck. And so they care about the policy that's coming out in DC.

To date, we have not seen the hyperscalers leaning in to own outright the generation assets. I think they would tell you it's just not their core business. The power companies, that is their core business, and so why mix that up? That said, this is all moving so quickly. And so, if they form the point of view that would be a more efficient, faster path to getting the power, maybe, right? I think a lot of things are on the table.

I think longer term, you mentioned SMRs, so small modular reactors, which is an emerging technology of nuclear plants. There is a vision. And so SMRs are around 350 megawatts, which is a good size, you know, an appropriate size for medium-, small-sized data centers, but they certainly can be stacked for larger data centers. There's a vision in the technology sector that maybe, just maybe, as the SMR technology advances, it can be part of the modular construction design for a data center.

So a data center has the shell, the SMR, the chips, and you're good to go, right? So that's some vision for the future. Whether we get there or whether the power companies continue to own the assets, time will tell.

**Allison Nathan:** Is there any concern that we are going to be so focused on build that we're eventually going to over build in a sense? I mean, when we think about there's some concern that data centers might get over built.

**Rebecca Kruger:** So it's a great question, and what

I'll -- you know the history of the power sector. There have been many booms and busts. And there's been a lot of capital and money loss on over build cycles. Companies have gone bankrupt.

And so what was so interesting about the last call it 18 months, I actually think the power sector was the last group of folks to believe in this demand story because I think they had PTSD from the last boom and bust cycles. And so that's shaping the power companies' approach to this build-out in some really important ways.

Data centers and the life cycle of a chip is four years, would you say, George?

**George Lee:** It's a matter of debate, and it's somewhere between three to six years, depending.

**Rebecca Kruger:** Yeah, okay. So --

**George Lee:** Probably on the shorter end in my view.

**Rebecca Kruger:** Right. And so therein lies the challenge, right? Which is the power plants and transmission lines, these are 30-year assets. And so the last thing a power company wants to do is build this capacity solely for this customer and then be left holding the bag when, four years from now, the data center is obsolete, right? Or not in use anymore.

And so it's leading to contracts that we're seen being struck between the power companies and the hyperscalers on certainly minimum tenures and return on enough capital during the contract tenure. And so the power companies feel good that their investments are being protected, and the hyperscalers are getting what they need in terms of the power.

And as you turn up the dial on the power price, what does that do to the overall hyperscalers' return on the data center complex? It's not much of a needle mover because it's such a small input on the overall cost. And so I mentioned before that it's like these two puzzle pieces that fit really well together. Power companies are very price sensitive. I think a hyperscaler would never tell you they're price insensitive, but they have a little bit more flexibility in terms of what they're able to pay and the terms that they're able to agree to.

**Allison Nathan:** So interesting. So we've talked about the supply chain constraints to building out this infrastructure. Are there other constraints that we should be focused on? Regulatory constraints or something else that we're missing here and that's going to make this even more challenging?

**Rebecca Kruger:** So there's a couple. All solvable ultimately but craft labor is one. And so there's a lot of talk of new nuclear getting built. The last nuclear plant that got built in the US at its peak had north of 10,000 workers on site. There's talk of, you know, we are entering the next nuclear renaissance. You can only imagine how many workers just to build out those nuclear plants are going to be required.

But even putting nuclear to the side, building out transmission lines, building out gas-fire generation, we expect a real effort, an advocacy effort from DC, on pointing people, workers, back towards these trades because it's critically important. We are short on labor.

And then policy, to your point. And we've seen President

Trump, his first day in office declared a national energy emergency. And so there has been a flurry of executive orders and pushes on policy to streamline permitting, to try and clear the way for new nuclear to get built, and there's many others that have been happening as this administration tries to get more firm baseload power built onto the grid.

**Allison Nathan:** So what does this all add up to in terms of deal flow in the sector?

**Rebecca Kruger:** Yeah, so it's been very, very active, both in terms of M&A and strategic financing. And so on the M&A side, because megawatts and the overall power infrastructure complex is becoming such a more valuable and scarce asset, you're seeing a lot of consolidation. This year alone we've seen $30 billion acquisition of a large gas-fire power portfolio. We've seen a 12 billion acquisition of, you know, something similar. So a lot of consolidation happening there.

And then in terms of strategic financing, there's a lot of pockets of private capital that are trying to invest to help fund the build-out of all of this infrastructure. So we're sitting right in the middle of all of that, trying to match the capital with where it's needed so that this power can get built as efficiently as possible.

**Allison Nathan:** Interesting. I mean, as I'm listening to all of this, I think there's just a bigger question here, which is AI going to really drive a transformational shift in the US power grid and landscape? Even the global power grid and landscape? Do you see a reshaping of the power landscape off the back of all this?

**Rebecca Kruger:** I think a couple comments there. Number one, the US power sector was already under-investing, and there were some reliability concerns that were coming. And so this huge demand story is putting everything front and center all at once, and it's forcing policymakers and every other stakeholder in this big puzzle to focus on these problems and solve them. So that's a good thing. That's a really good thing.

And you've got stakeholders across the board on both sides of the table who have deep pockets and deep financial resources throwing their resources at this problem, so that's a good thing for the country because, at the end of the day, reliable, affordable power is a good thing for us as a country.

I do expect more innovation. Carbon capture, for example, is getting a lot more focus and investment than it was previously, and so that's basically take your gas-fired power plants, put carbon capture and sequestration equipment on it, and it lowers the overall emissions of that power plant. That's a great thing, right? And it's a win-win because the hyperscalers ultimately who will be off takers there, they do care about the emission content of their power.

Maybe the last thing I'd say on this is I think fundamentally how we can produce and consumer energy in this country is going to be changing. Over the last 20 years when we had flat demand growth, there wasn't the price signals that really triggered and motivated innovation. We are seeing that in spades today, and it's a really exciting time as a result.

**Allison Nathan:** So interesting. Thanks again for joining us, Rebecca.

**Rebecca Kruger:** Thanks for having me. This was terrific.

**George Lee:** Great discussion, as anticipated. I want to feature the thing that Rebecca ended with, which I think there is an optimistic frame. There are real challenges here. You have regulated utilities who own fealty and obligation to rate payers. There's a lot of concern about continuity and price of electrons for them. This is clearly a generational challenge to meet this need. And yet you are interposing a set of entities that are the most innovative, tech-forward entities in the world. They now can turn their attention to bringing more efficiency, more change, more new ideas to this older ecosystem.

And I think it promises the potential, as your question signaled, for a very high rate of change in this kind of slow-moving ecosystem in the next five to ten years. Frankly, we'll need it.

**Allison Nathan:** Absolutely. Couldn't agree more. I mean, bringing innovation to this sector, you know, has got to be a win-win.

**George Lee:** But to their credit, and as Rebecca mentioned, really responding, partnering well with these companies. This is not a population of companies who are burying their head in the sand. Like, they recognize the opportunity, the need, and I think they're really rising to meet the challenge. Pretty inspiring actually.

**Allison Nathan:** Absolutely. Well, thanks again, George. I am looking forward to our next conversation.

**George Lee:** As am I. Thank you.

**Allison Nathan:** This episode of Goldman Sachs Exchanges was recorded on Wednesday, July 9th. To learn more about this topic, you can find a link to the report, "Powering the AI Era," in the show notes. I'm Allison Nathan. Thanks for listening.

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