Research @ Citi Podcast, Episode 2: Gridlock — The Global Power Problem

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Guest: Tony Yuen, Head of Energy Strategy, Commodities Research, Citi

Transcript:

Lucy Baldwin (00:00)

Welcome to the Research @ Citi Podcast. I'm Lucy Baldwin, Global Head of Research at Citi. In each podcast episode, we bring you our thought-leading views and analysis across asset classes, sectors, and economies from around the globe. Now, let me hand you over to our host today.

Rob Rowe (00:22)

Hi, everyone, and thanks for joining. I'm Rob Rowe. I'm the U.S. Regional Director of Research here at Citi. And my guest today is Tony Yuen, who is the Head of Energy Strategy on our Commodities team, and the subject we're going to be talking about is something that I'm very, very intrigued by, which is: Power grids are extremely important, as you might imagine, as we move ahead and expand the digital economy. Tony, thanks for being with us today. You just published one of our Must C publications on the overall power grid. Let's start off with: Why is this so important? Why do we need to focus on the power grid at this moment?

Tony Yuen (00:57)

Sure. Thanks. So it was fun working with the team on this analysis in the power grid, and many of us always know that the power grid is kind of important. But you also take it for granted. Electricity just shows up when we flip on the switch and our phones just charge. In fact, sometimes we might think that the distribution charges on our electricity bill are too high. So what's going on? Well, the power grid is literally the backbone of modern society. So the grid could also be the ultimate bottleneck. Why is that? Well, many of us live in and around cities, but power plants are far away. So we need power lines to take the power supply to where demand is. But we also don't want to see power lines in our backyard. So if power lines and demand growth were stagnant, then the grid won't be as much of a problem, other than just replacing old lines with new ones. But there are, you can argue, once in a hundred years supply and demand shocks happening all at once that will require more power lines to be built. And these shocks are big and structural in nature.

So first, power demand will be quite strong in the future, driven by data centers, AI (artificial intelligence), the rise of electric vehicles (EVs) — and increasing electrification of the economy. For example, Sam Altman of OpenAI and a number of tech executives have said that compute and energy are the bottlenecks in the future to AI deployment. Cars also haven't really changed over the last hundred years since the Model T came to market, but suddenly electric vehicles have disrupted transportation sector in size. So the growth of EVs might slow, but EVs are not going away. And second, more power supply will be coming from renewables. Energy transition is happening. But renewables are typically far away from data centers and cities, or demand centers, or where most people live. And the footprints of renewables is also large — multiple times that of fossil fuel power plants — that the energy transition process is really looking to replace. So if we need big space, renewables have to be far away. Even though renewables growth had been going on for over the last decade and before, they are getting larger in the overall generation mix, that the power system is

having more issues integrating. So we need more power lines to bring supply to demand. But there are problems to building and expanding transmission and distribution grid. In fact, the inability to expand the grid meaningfully would impede economic and technological progress.

Rob Rowe (03:23)

Tony could I take it a step back just for one second to unpack this a little more. Before we get into renewables, what is the scope of the problem, in a sense? Because I know California has had issues with brownouts. I know that sometimes data centers have had a hard time sourcing electricity. They also have HVACs as well. And also, you bring up a good point, which is: We have to think about things more in terms of the digital environment now, than we do traditional economic growth, right? For scope, how big is this issue?

Tony Yuen (03:56)

Yeah, that's right. So if you think about on the demand side, let's say, you know, took the U.S. case in this example, right? Power demand growth could go from the low 500 gigawatt range to roughly about 600 gigawatt range by 2030 — or roughly about 15% growth in total, about 2% growth per year. So this is almost like if there's no data centers, and EV's driving a power demand. But the population rises by 15% between now and 2030 — the U.S. population, right? So, you know, the electricity demand could rise that much. And now, 2% per year for, you know, some people doesn't sound like much. But for the utility industry, that's really grown accustomed to flat and declining growth and usually take years to plan and build new power infrastructure, then ramping up construction infrastructure is not easy at all.

And then on the supply side — beyond the demand side — there's also the Inflation Reduction Act, or the IRA, in the U.S., there's turbocharging renewables growth as well. Now, granted, the cost of solar and wind have gone down quite a bit and making them attractive. So it's not just regulatory side, but really the cost of solar and wind have gone down quite a bit. If you just move beyond the U.S. as well, geographically, globally, if you look at the advanced economy, right? They have to get used to rebuilding, expanding energy infrastructure. Because we've heard many times that, "Oh, the power grid is aging," and whatnot. So there's the replacement involved already on top of the power demand growth. Then there's turbocharging growth in emerging markets, because the natural power demand growth over there is higher because of strong economic growth, and power demand growth will get even stronger with more data processing and EVs, whatnot.

Then if you put all that together on the power lines front. So how big is the issue? The International Energy Agency, or the IEA — which you could say is the global public agency on all things energy data analysis — estimates that power lines globally will need to double in length between now and 2050. But there is more. Old power lines need to be replaced. So the requirements on new power lines are well more than doubled.

Rob Rowe (06:07)

Tony, I mean, what do you think are the steps that need to be taken in terms of either reconfiguring or building out those distribution lines, and what are the potential impasses there? And I'm thinking more about the U.S. And I think what we can do is also, I'll also, as a second question, I think I'd be curious to know, do other regions of the world have the same issues as the U.S.? But let's start here with what the challenges will be.

Tony Yuen (06:39)

Yeah. The issues are actually quite common across countries, and we've seen some media organization having some reports about the power grid issues. Because if you think about it, the deployment of distribution lines, which is at the local utility level, would be within kind of a few years, right? Just think about that — a few years. And if you look at this deployment time for long-haul transmission lines where you bring renewables from, let's say across state lines to, let's say, demand center of cities, whatnot, could be well more than ten years. Notice the timing mismatches. Data centers are getting built right now. More electric vehicles are on the road, and solar and wind generation capacity is going up quickly. But they're all far away from each other. And these are happening not just in the U.S., but all over the world. And the connection queue for renewables is really long. So right now, multiple renewables projects could compete for transmission capacity expansion, whatnot.

Why is building power lines so long? Well, if you think about it, permitting takes longer time than even construction in a lot of, you know, developed markets because of complex administrative processes, not enough government staffing, and legal challenges. Remember that many people don't want to see or have power lines in their backyard, right? So it's not uncommon for extra high voltage over that line to take five to 13 years to go through permitting, construction process in developed countries. And also multiple authorities and jurisdictions are often involved because power lines crosses different regions. And there are various impacts on the environment and local communities, whatnot. So each of the authorities need to review and accept plans before approving. For example, take the case of Germany. The alternate DC line in Germany required 13,500 permits. The possible solutions to the permitting side, so the solutions include streamlining permitting procedures such as concentralization and permit issuance, setting maximum timelines, using existing right away, destinating kind of infrastructure corridors, or raising the threshold for application to connect to the power grid.

But naturally, getting stakeholders, many stakeholders involved and consulted, just takes time, right? And this is not also just an issue of bureaucracy. There are also interesting physics about the flow of electricity that utilities and planning agencies really, really have to study in depth and coordinating cross-agency utilities. So historically, this technical assessment process takes a long time. But technology, and interestingly, even though AI demands power, but AI can also help with coordination and modeling of the power grid and assessment of how power grid may integrate renewables and supply power to data centers and all of that, right? And finally, financing and construction of power lines are also an issue because they’re kind of misaligned business models, high cost of capital, long project lead time, whatnot. Because the capital cost is upfront. But the paybacks often regulated by law. And the climate risk as well, which you mentioned on the California side, right? For example, what California goes through with wildfires and all. So there's this climate risk to the investment process. In other places globally, politics are inevitable because if power lines go through different countries, there's going to be geopolitical risk within financing as well. So the issue is, you know, inherent with building power lines.

Rob Rowe (10:17)

And, Tony, do you think that this is the sort of thing that could become a big U.S. election issue this year? Because I imagine by, we'll have gone through a summer. We have more data centers. Are we starting to see the effects of this in various states of the Union or, you know, around the world, are we starting to see moments where the power grid is being challenged?

Tony Yuen (10:42)

Oh, absolutely. Because you can think about it from multiple levels, right? One is really at the local level, people typically, as we talked about, don't really want to see power lines, you know, not in our backyard, right, so for them there'd be issues. But also, if you think about, even though the market's been building renewables, whatnot, for the past decade or more, but now you have more renewables that's now stressing the grid, and that means the grid needs to be replaced. While the grid infrastructure's kind of old, right? You're kind of kick the can down the road to replacing. Then suddenly you've got this surge in power demand. As we talked about before, this is almost like a once-in-a hundred-year transformation, right? Suddenly, transportation sector is going to change from gasoline and diesel power cars to electric cars, and then data centers, AI, and whatnot, just exploding, right? And to connect all of these together, you need power lines, right? So that's why everything is coming to a head.

Rob Rowe (11:42)

And Tony, in terms of solutions, you mentioned renewable energy. Is that something that you would envision ramping up a lot more than it has already? In other words, you have these bottlenecks. So maybe the ramp up on the energy side or the supply side may not happen as quickly as a result of it not being able to be delivered, you know, efficiently, right? So you could have all the power in the world, but not be able to deliver it. Maybe that's kind of the cart before the horse or whatever. But how do you see this playing out? And who do you think, you know, in a way, who do you think of the winners and the losers here as we go forward?

Tony Yuen (12:18)

Yeah, you're absolutely right. Because you know, the cost of renewables definitely have come down. And so there's many renewables projects getting put up, right? But, you know, you've got this bottleneck, right? It's not just, you know, the permitting regulatory process, but itself assessing the power grid, how you integrate all of these things, you know, naturally takes time. So that's why we have to really step back to really think more about strategically about the power grid, which is not just about building power lines and putting in batteries, even though both are still important.

And one key aspect about this report is really examining the kind of hardware and software solutions just beyond building power grid because we know the obstacles and whatnot, right? So the opportunities include much greater use of long duration energy storage. So, you know, the acronym will be like LDES. And there's wide application of demand response, which, you know, more software solutions can actually help on the how demand picks up or ramps down, and then how you integrate decentralized energy systems, and people talk about microgrids and whatnot, and flexible generation. There's also adopting kind of automation and artificial intelligence, and AI could be transformational, not just on the demand side of energy, right? You know, using a lot more power demand. But really in forecasting weather, predicting renewable energy generation, optimize how the grid will be operated — not only in long-term planning, but real time operation. And this is where we're really glad that the U.S. government's National Renewable Energy Laboratory of the Department of Energy—which has done extensive analysis on the subject—is, you know, apply the framework also in our work right here that really puts some structure around how we categorize these solutions.

Rob Rowe (14:21)

Was there anything in the last bill that helped the power grid? I think you alluded to it a little bit, but I'd be curious to know. And do you think that there's a political solution either through an infrastructure bill or something along those lines?

Tony Yuen (14:36)

Yeah, absolutely. So the Department of Energy certainly is empowered to do much more coordination around building power lines and whatnot, and there are certain segments within the bill that encourages these alternative solutions. But then I think part of it is you still need further development and further legislative encouragement in building these things, right? Because, for example, there are several aspects beyond just building power lines, right? We kind of touch on some of that, four of them: system operations, having more flexible supply, regular use of demand response, and more extensive use of energy storage. And some of the regulators actually talked about, it just makes sense to make some of these improvements, but sometimes incentives is not really there for some of the incumbents to make those improvements, right?

So for example, let's say we talk about system operation aspect. On the hardware side, there is something called the dynamic line rating, which means that, for example, the power lines have certain capacity to transmit electricity. But right now, the capacity is considered fixed. But, if you put in sensors and then put in, you know, other kind of modeling and whatnot, you can actually see that power lines would have different capacity, you know, under different weather conditions and electricity transport conditions, right? But if you think about incumbent, you know, they might actually want to build more power lines, right, because of cost of service, how they are compensated and whatnot, right, on the return, cost of return, and, you know, whatnot, right? And so that's why, the incentive issues, I think these are, step-by-step process going forward. And further regulatory improvements to encourage more of these steps and improvements to be taken.

Rob Rowe (16:25)

I could probably talk about this all day, Tony. But let me ask you just a last couple of questions here. One is, are there challenges to totally consolidating the grid? Because there are separate, I guess, utilities within the U.S. And also, does nuclear play a role here? I know there's a revival in a sense, of nuclear power. Does that play a role?

Tony Yuen (16:51)

Sure, yeah. So historically, the grid is somewhat more fragmented. And that's why the industry and regulatory body recognized the need to really integrate certain aspects of the grid. And there are also political issues, you know, why certain grids are not part of the broader grid. So there are something called the reliability councils. I'd say there’s the Mid Atlantic one reliability council, then in the Midwest, different ones, and then the Southeast one, right? Really, it’s try to coordinate these things.

But then because of the interesting physics about electricity transmission. So sometimes integrating that involves substantial modeling, and that is going back to why planning new power lines take a long time. But the new modeling technique, AI, for example, in building a so-called digital twin of the power grid can help to understand and model the power grid much more. So hopefully there will be further advances over there. But there's also a frequency aspect, you know, as in power, you have the 50 hertz frequency, 60 hertz frequency or different frequency, you know, rate and whatnot. And then the Texas grid, much

of Texas is actually not really connected to sometimes Eastern interconnect and Western interconnect as well. So there are issues that a much bigger grid in terms of coordinating and not only, you have to bring in a lot of jurisdictions or authorities, but also the technical modeling aspect is difficult. But at least the modeling aspect potentially could get much easier with AI model.

And you bring a really good point about nuclear. So it's a great question because, you know, the field is fun, and, you know, I was fortunate to be involved in the proposed building of the first third-generation nuclear power plant before I joined Citi. And here's the perspective: Nuclear would certainly provide stable power supply for, let's say, data centers, it's clean and whatnot, in terms of emissions. And existing nuclear power plants could be more valuable because they are readily available. It's already there. But bringing back a retired nuclear power plant or building a new one would take time because it would be measured in years. And here's why very quickly in three ways, right? If an existing plant, fourth-generation outputs, get bought out, let's say, by a tech company and whatnot. Some of that electricity supply still need to be needed to replace a lost generation available to the broader public from this particular nuclear power plant. So that means that you still need additional generation from somewhere. And then the second aspect is about retired power plants. So if there's a repowering of a retired nuclear power plant, the time needed to pass inspections, re-certification and refuel will still be long. Safety is paramount in the nuclear business. And finally, if you build new plant, a new plant, if one is needed, it will take years because of the time for permanent construction. Again, getting safety and environmental approvals in addition to having enough qualified professionals and equipment will really take time. Many developed countries including the U.S. have not built nuclear power plants in scale for a long time, so a lot of the professionals have since retired after the building boom slowed and then stopped some 40 years ago. So nuclear, long term, could be great, but short term, it probably will take some work to get it to help.

Rob Rowe (20:12)

Well, Tony, I want to thank you for all of your insight and thought leadership on this. We do have that Must C publication that will be published publicly as well as institutionally. So look for that for more detail on this subject. I have to say that you can hear the challenges from what you've been saying. And I can see that this is not a short-term solution to this power grid issue. So we may expect to see other challenges along the way. But I did hear you on long-duration battery storage. I heard you on software and AI. Perhaps those are some more immediate solutions. And then organizing the grid — I think you're going to need to have government support on this as well. But thank you so much for your comments today and thanks everyone for participating on the podcast today. Thanks very much.

Lucy Baldwin (21:01)

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