CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Power Purchase Agreements for Grid-Aware Renewable Energy Procurement

—Transcript of a webinar offered by the Clean Energy Solutions Center on 9 May 2017—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

Barbara O'Neill	National Renewable Energy Laboratory (NREL)
Tara Fowler	Xcel Energy
Ilya Chernyakhovskiy	NREL

This Transcript

Because this transcript was created using transcription software, the content it contains might not represent precisely the audio content of the webinar. If you have questions about the content of the transcript, please contact us or refer to the actual webinar recording.

Katie

Today's webinar is focused on the power purchase agreements for grid-aware renewable energy procurement. Before we begin, I'd quickly—I'll quickly go over some of the webinar features. For audio, if you have—you have two options. You may either listen through your computer or over the telephone.

If you choose to listen through your computer, please select the mic and speakers option in the audio pane. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option. And a box on the right side will display the telephone number and audio pin you should use to dial in. If anyone is having any technical difficulties with the webinar, you may contact the GoToWebinar's help desk at 888-259-3826 for assistance.

If you would like to ask a question, we ask that you use the questions pane, where you may type in your question. If you are having tech difficulty viewing the material through the webinar portal, you will find PDF copies of the presentations at http://www.cleanenergysolutions.org/training. And you may follow along as our speakers present. Also, the audio recording and presentations will be posted to the Solutions Center training page within a few days of the broadcast and will be added to the Solutions Center YouTube channel, where you'll find other informative webinars, as well as video interviews with thought leaders on clean energy policy topics.

Finally, one important note of mention before we begin our presentation is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center resource library, as one of many best practice resources reviewed and selected by technical experts. Today's webinar agenda is centered around the presentations from our guest panelists, Barbara O'Neill and Tara Fowler, who have joined us to discuss power purchase agreements for grid-aware renewable energy procurements.

Before we jump into the presentations, I will provide a quick overview of the Clean Energy Solutions Center. Then following the panelists' presentations, we will have a question and answer session moderated by Ilya Chernyakhovskiy of the National Renewable Energy Lab, where the panelists will address questions submitted by the audience. At the end of the webinar, you will be automatically prompted to fill out a brief survey, as well. So thank you in advance for taking a moment to respond.

The Solutions Center was launched in 2011 under the Clean Energy Ministerial. The Clean Energy Ministerial is a high-level, global forum to promote policies and programs that advance clean energy technology, to share lessons learned and best practices, and to encourage the transition to a global clean energy economy. 24 countries and the European commission are members covering 90 percent of clean energy investment and 75 percent of global greenhouse gas emission. This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government policymakers design and adopt policies and programs that support the deployment of clean energy technologies.

This is accomplished through the support in crafting and implementing policies related to energy access, no-cost expert policy assistance, and peer-to-peer learning and training tools, such as this webinar. The Clean Energy Solutions Center is co-sponsored by governments of Australia, Sweden, and the United States, with in-kind support from the government of Mexico. The Solutions Center provides several clean energy policy programs and services, including a team of over 60 experts—global experts that can provide remote and in-person technical assistance to government and government-supported institutions.

No-cost, virtual webinar trainings on a variety of clean energy topics, partnership building with development agencies and regional and global organizations to deliver support, and an online library containing over 5,500 clean energy policy-related publications, tools, videos, and other resources. Our primary audience is made up of energy policymakers and analysts from governments, technical organizations in all countries, but we also strive to engage with private sector, NGOs, and civil society. The Solutions Center is an international initiative that works with more than 35 international partners across its suite of different programs.

Several of the partners are listed above and include research organizations like IRENA, the IEA programs like SE4ALL, and regional focused entities such as ECOWAS Center for Renewable Energy and Energy Efficiency. A marquee feature of the Solutions Center provides is a no-cost expert policy assistance known as ask an expert. The ask an expert service matches

DRAFT

policymakers which—with more—one of more than 50 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of renewable energy policy and power purchase agreements, we are very pleased to have David Jacobs, the director of international energy transition, serving as one of our experts.

If you have a need for policy assistance in renewable energy policy and power purchase agreements or any other clean energy sector, we encourage you to use this valuable service. Again, this assistance is provided free of charge. If you have a question for one of our experts, please submit it through our simple online form at http://www.cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations.

Now I'd like to provide a brief introduction for today's panelists. First up today is Barbara O'Neill. Barbara is the grid integration manager at NREL, where she leads projects and engages stakeholders domestically and internationally to provide information on renewable energy integration practices and technology. Following Barbara, we will hear from Tara Fowler, the manager of renewable energy power purchases for Xcel Energy. Tara provides leadership and directions in negotiation and administration of long-term renewable energy purchases agreements between Xcel Energy and power suppliers.

And our moderator for today's question and answer session is Ilya Chernyakhovskiy. Ilya is a co-author of USAID and NREL's Greening the Grid toolkit. And with those introductions, I'd like to welcome Barbara to the webinar.

Barbara Thank you, Katie. Okay. Welcome, everyone. Thanks for being with us. Hold on a second, please.

Katie Just one moment, everyone. We're having a little bit of technical difficulties. We'll clear it up and be with you in a second.

Barbara I am [inaudible]. Do you want me to—okay. I'm gonna go ahead and start. And we're gonna be pulling those slides up in a second. So welcome and thanks for being present. We're going to talk about power purchase agreements, but just to caveat this, we're not talking about PPAs in general. There's many provisions in a PPA that address obligations and risks and all sorts of contingencies certainly on the legal end. We can negotiate these things for months.

We're gonna be focusing on the provisions in the PPA that provide services back to the grid for reliability and security considerations for stability of that electrical system. It's important that renewable generators, as they become increasing prevalent, are good citizens to the grid. And we'll sort of go through some of the ways which we can obligate those generators to participate in that way.

DRAFT

So for the agenda, we're gonna start with the—just sort of an intro or just cover some basics about PPAs. So when I say PPAs, power purchase agreements, or purchase power agreements, we mean the same thing. And I also might use the acronym RE for renewable energy or VRE, which stands for variable renewable energy, implying wind and solar. So in other words, we're not gonna be focusing on services that could come from, say, hydro plants or geothermal or biomass. Primarily the wind and solar plants will be those variable renewable energy generators.

And this is clearly because the sun and the wind, which are fueling those generators, are moderating based on weather, based on meteorological conditions. We're gonna go into specific considerations of how you might structure your PPA to ask for some of these services. And then I'm gonna pass it over to Tara, who will talk about Xcel's procurement of renewable energy as an investor-owned utility here.

So some of the key takeaways, which I'll hit on the back end, as well, are that as renewable energy penetrations increase, you're going to have a different system. You're going to have more non-synchronous generation replacing synchronous generation. And I'll get into what that means in a little bit more detail later. But never fear; we have the physical ability to provide some of those services with these new technologies.

So there have been so many advances in power electronics that to ask your wind and solar generators to provide some of those services is not out of the question, and it's not uneconomic. And all of this is going to contribute to keeping the electrical systems stable and secure. Reliability is obviously very important to all of the providers, all of the utilities globally who are obligated to provide their customers with a constant supply of high quality power. But keep in mind that there is no set, one size fit all—fits all approach, and everything is sort of system dependent.

Here's a slide on definitions. We're gonna kind of skip through that. I'll cover these definitions as we encounter them, but this will be a good reference for you to go back to with your slide deck. Again, VRE, for variable renewable energy. And when I say IPP, I mean independent power producer. So in other words, another party who will be the owner slash operator of a renewable energy generating plant in contractual agreement with a utility.

So as far as PPAs, moving on to this introduction, PPAs are one of those key mechanisms that utilities use to procure renewable energy. And a lot of utilities when they're first getting into the game, they don't have experience typically on running that kind of plant. They're good at running combustions turbines or steam turbines or those sorts of more traditional fossil units. And so it's a good way for utility to procure from some other developer who knows how to go out and find the land lease options and knows how to set up anemometers or paradometers and take measurements for solar and wind and knows how to kind of develop that type of project.

DRAFT

DRAFT

And then the utility can get into contract with that entity at—in a pretty risk-free position. Because what they're gonna pay for is the kilowatt-hours. So it'll be a dollar—a monetary unit per kilowatt-hour. So it's energy only typically contracts, where they just pay for what they get. The length of the PPAs are long-term. So we're looking at 20 to 25 years. And that is kind of based on the warrantees for some of the equipment used in wind and solar contracts.

And it's not to say that these plants won't go on running after that. As we have more and more generators who have been on for a long time—here in the US we've got—it's late 90s, early 2000s. We're getting experience with older wind and solar plants. And there are things you can do to kind of rehab them or maintain them. And they really do, we're finding, last longer than this kind of 20, 25-year warrantee claims.

But it's good to have that length of contract because your counterparty, your IPP, will have a better chance of getting financing. So they're gonna go to a project finance investor, and they're going to borrow the money to build this plant. And if they have a good, credit-worthy off taker, IE the utility, and they have a long-term guarantee that somebody's going to be buying this power, that will provide a lower debt—cost of debt to borrow that money. So the savings will ultimately be passed on to you, the utility.

So it's important to establish long-term contracts and the legal obligation of all parties in that contract. And I say all parties. Yeah, usually we're talking about two. We're talking about a buyer and seller, an IPP and a utility. But nowadays there's some more kind of out of the box, atypical contracts, where you could have a corporate buyer who's interested in renewable energy, such—the Googles or the Amazons or kind of the big data centers.

And perhaps they're going to contract with an IPP who will dedicate the output of their wind or solar plant to a corporate buyer. But because that data—say a data center has an obligation to buy power from the utility as the traditional customer base, and the utility's obligation to serve that area, the utility would be a three—it would be a three-party contract, a three-way contract. So utility would buy from the IPP [inaudible]. And the quarter would be obligated to buy that dedicated power from the IPP.

So PPAs do help to overcome some of these major barriers. For a utility—what they've been dealing with for decades is commodity risk. They've been dealing with variable fuel costs. And for a while back in the mid-90s, Saudis were producing oil flat-out. Everything seemed stable and mellow. And then we've got big swings. Gas prices go through the roof.

And then we've got shale gas plays and fracking. And now, at least in the US, gas plays is too low, it's too stable. But it's hard for utilities to bank on those costs as they move around. And it's hard for the economies of some of these areas who can't guarantee that their price of power for any sort of manufacturing activity and that kind of thing is gonna stay stable.

So moving to a renewable energy procurement means stability with respect to that variable cost—sun, wind. These are free fuel sources. And so that's why it's great for a utility to get into that game without having to rely on market forces. Now—and I already mentioned on the other side, on the flip side of that, developers themselves will be able to secure project financing better if they have one of these long-term contracts.

So PPAs are designed—moving on to the next slide—with kind of an allocation of risk in mind. Dispatch risk is one of the key things. And that means whether or not the IPP is going to be guarantee that the utility will pay for all of the power that they're producing. And there could be areas of congestion on the transmission system, which limit the movement of power to the end user, the consumer of that power. Or some other reason why—either an emergency or some other reason on the transmission system why the power might be curtailed.

There's also economic curtailments, where a utility might not need the power because they have to, say, have a must-run unit, one of their big basal coal or nuclear units keep running. And within that PPA, you want to specify the terms of whether or not curtailed power will be compensated. And in some cases it's not as black and white as yes or no. It could be that you have a bank of compensable curtailment, and then beyond that it's non-compensable.

And [inaudible] to the IPP to assess the risk of being able to transmit that power. With respect to allocation of cost risk, certainly that IPP needs to have their tariff cover their debt and provide the debt service as well as the return to their investors on the equity side. And you want to set up a 20 to 25-year price that's either completely constant and fixed, or perhaps it inflates at some set rate, some set percentage rate. Or you could index it to some economic indicator that could be published by the government or that sort of thing to track, say, producer price index or some cost of labor to reflect changing conditions over the 20 or 25 years, as long as it's a widely available and arbitrary economic indicator.

For interconnection, you need to well define that point of interconnection. So at that physical point, you're gonna have two meters. You're going to have the utility's meter, by which they assess how much revenue they're giving back to the IPP. And then you're gonna have your IPP, who installs their own meter basically to double check the utility's assessment of that revenue and to calibrate those meters and make sure they're in sync.

So you want to make sure at that point—at the point of interconnection, when the power sort of passes ownership to the utility, who's responsible for, again, transmitting that power. So there's two pieces. One is can the project get interconnected on time? Who's responsible for each step of that process? And then who's responsible for making sure the power gets transmitted from the POI onto the end user?

Okay, moving on to the key focus of this focus, is these flexibility and reliability considerations and provisions within a PPI. So grid services—the term grid services refer to ancillary functions that support these—the system requirements for stability on the grid. There's sort of two categories of those. One would be in steady state, business as usual, kind of normal operating circumstances, what services are provided. And then there's the other category, which is following a grid disturbance, what can generators do to help the system regain that sort of normalcy or that steady state?

So by grid disturbance, I mean a deviation of frequency or a deviation of voltage. And those two things do deviate under normal circumstances. And in some systems they move around quite a lot. The—with respect to frequency, the bigger the system, the harder it is to get that system to move, when there's so many components. With smaller systems, such as in island communities, small events can have a bigger impact on the frequency.

Because if you have, say, one generator that goes off the grid, has some outage, some unplanned outage, that's gonna have a bigger impact on that frequency than if you were operating in Europe or the eastern interconnection here in the US. So typically, traditionally, vertically integrated utilities, which own their own generation fleets, have the generators mostly for free contributing to that reliability. But in kind of the new world, this new paradigm where you are going to have more renewable energy generators, more IPPs, and you might have different markets or just different institutional frameworks that account for these grid services, you're going to make sure that the ancillary services are provided.

And some of those include the frequency type services, frequency response, load following, frequency regulation. And some of them are about having enough power to match that supply and demand for having enough reserves that are spinning and that sort of thing. You just have to keep in mind that since power is instantaneous and not—it's not able to be stored without the use of a battery or a flywheel or some sort of storage device—pump storage, hydro—you have to match everything in real time. And the responsiveness and flexibility of the grid will necessarily be increased as the variability of that increases with more renewable, variable renewable generation.

So as it is right now, utilities look at, say, a daily load curve. And as folks turn on their light switches and manufacturing plants start up or change their shifts, there—the load that they're responding to is naturally variable. Utilities are good at responding to variability. They've been doing it for decades. But when you have wind and solar generation as the first off the line, the first off the stack to be dispatched to meet that load, because of cloud passage and variation in wind speed, that power is naturally variable.

And so when you net the load with the renewable variable generation, what's left is that net load curve that utilities have to meet. That's going to be—it's going to have steeper ramps or spikier spikes. So the higher variability requires a more flexible system in order to accommodate it. The good news is that it's doable with these technical capabilities that these plants offer.

So it's kind of interesting that the solar and wind generators who are part of the [inaudible] and for the increased need for flexibility can also be part of the solution by providing those capabilities. Okay, moving on. So I think we've covered a lot of this. What I mean by non-synchronous is where a generator is actually a DC motor that goes through a converter or an inverter, depending on if it's getting converted back to DC in order to connect to the system, as opposed to your traditional thermal units, which are synchronous, which are connected in sort of an AC mode. And we'll get into that a little bit, as well.

By institutional measures, in some cases there's grid codes in countries; in some cases there's a framework for interconnection agreements. In some cases there's nothing. And all of that technical requirement type language is embodied in the purchase power agreement itself. But certainly if you have a PPA between two parties, you want to either contain all of these technical requirements within that doc or within an appendix to that doc, or you want to reference the appropriate other agreements or other obligations of the party.

And there's—there are two categories again. There's the requirements to interconnect a plant, and then there's the requirements to be able to transmit that power, or how they need to operate in that sort of steady state mode. So it's important to go through those and spell out all of the things that both parties are expecting. Okay, moving on.

So now a little bit of background kind of from the engineering side. So we talked about supply and demand having to be in balance. And systems operate at a specific frequency. And this is because they're alternating currents. So basically the frequency of that waveform is what determines the frequency of the grid. US is a 60 Hz grid; Europe is a 50 Hz grid.

But to be clear, if I plug in a frequency here in Colorado, and I plug in one over in Seattle, they're gonna read the same thing. It's a ubiquitous sort of measure across the grid. That contrasts with voltage, which is more location dependent. It depends on how close you are to the source of the voltage, IE generation source. So this picture here sort of shows you with that shaft on the right side of the screen that the synchronous generators are actually connected kind of in tandem with the frequency of the grid.

So if a generator falls off and the frequency dips, then the other generators will sort of take up the slack. They will sort of speed up to keep that shaft rotating at 50 or 60 Hz. That's opposed to solar and wind, which are not connected in that way because they're not synchronous in that way. They don't provide this automatic, inertial response. There are other capabilities, however, that can be utilized to help with that frequency service.

Okay, so we're gonna move on to the frequency range requirements, which might be a provision in your PPA. So by “deadband”, I mean an area of frequency—so 50 or 60 Hz plus or minus a certain amount. That provides a deadband. That provides a delta frequency over which you want to require your independent power producer to stay connected. And that's important because that will help stabilize the grid.

And there are some instances where systems could theoretically be chasing their tail. If you've got generators that are responding by dropping off or ramping up and trying to get to a certain set point, that it's hard to stabilize.

DRAFT

So in order to create stability, you basically want everyone to kind of keep producing power when there's these deviations in frequency. Now, beyond the deadband, your grid code or your PPA could require what's called a droop response, where the change of power would be obligated relative to the change of frequency.

And we're not gonna go into that in too much detail. But the graph on the bottom right there sort of depicts this droop response characteristic of a generator. Okay. Now moving on to voltage. Voltage—in my mind, anyway, I think it's a little bit harder to kind of grasp. But basically there's a nominal voltage at which these generators are connected. And again, the more distant one is from that voltage source, the lower that voltage gets. So you can see it sort of—let's see—let's look at this graph.

There's a PV system here. And as you move to the left, the green line decreases away from nominal to the more distant you are from that PV supporting system, the voltage drops. And even without a source—on radio feeders, for example, at the end of the line they're gonna have a lower voltage than at the beginning because of that natural decline over distance. There are pieces of equipment that you could use to help that, which is a voltage regulator, to boost the voltage a bit. But the key is to require your generators to operate within a voltage limit.

So you want to say here's the nominal voltage. And then plus or minus some percentage off of that where that generator should remain online and remain operational as close to nominal as possible. So minimizing the impact of voltage fluctuations is important because it can actually damage the utility's electromechanical equipment. Okay, moving on to a little bit probably even trickier concept of reactive power.

So reactive power is something that is part of what we call a power factor calculation. A power factor is in effect a measure of a system's efficiency. So this illustration of the beer sort of sums it up, where the beer is actually the real power or the active power on a system, the power that can actually do work. Whereas the reactive power is kind of the foam on top. You need it, but it's not actually doing work. Well, why do you need it?

And it's because it creates an electromagnetic field for inductive motors to be able to work. So being as we're on an AC system instead of a DC system, there are many loads, many motor loads that require reactive power in order to be able to do their work. And it creates a stability of the system itself. So we have to keep the ratio sort of as close to constant as possible. And that represents the power factor.

Now, a utility can have that generator operate in a mode that is unity power factor. In other words, that same ratio of real power to apparent power. Apparent power is the total power. Or they could say, "Hey, I want you to keep your reactive power constant by modifying your real power." And if a generator is getting paid for the real power—they're getting paid for the actual kilowatts that are delivered, this is potentially less optimal for them. Because they might be limiting their real power in order to keep their reactive power

DRAFT

[inaudible] and such they could request a revenue for pushing down their real power in order to keep their reactive power constant.

Another control mode that might be required is a voltage control mode, where they're just going to worry about the voltage piece of the equation by modifying their own associate parts. So basically the power in an AC system is that vectoral sum of real power and reactive power. So back to sort of the Pythagorean theorem type thing, where A squared plus B squared equals C squared. That's the depiction of the total power, are those two pieces—the real piece and the reactive piece.

And the utility wants to specify how the IPP contributes to their voltage stability by requesting which mode they should have that IPP operate in. And they can also request that that IPP switch modes. So it'd be a provision of, well, how often are they allowed to provide the IPP with a request to switch modes? So you want to get all those things spelled out.

It's pretty technical. But you bring the engineers on and sort of figure out what's best for the system's total stability and the local grid needs. So another piece of the voltage puzzle is this voltage ride-through. So as an IPP is sensing the voltage on the system, just like they're sensing the frequency on the system, they're going to feel voltage fluctuations caused by other instabilities, small instabilities on the grid. And you want to require them to stay connected.

Because they have protective relays that strip off their equipment when the voltage deviates either high or low outside side of a band. And they do it because they're trying to protect their own equipment. However, again, to contribute to the stability and not exacerbate the problem that caused the initial voltage to deviate outside of that range, you want them to stay on. Well, for how long and at what deviation? And that is very system dependent.

And it depends on, again, the duration. So the graph here depicts—and this is PU. It means per unit. Voltage is usually represented as per unit to get that ratio that we talked about. If it's gonna be a large deviation, but it's only going to last for 150 milliseconds, you want to require, say, that IPP to ride through it. But if it's going to be a large deviation that lasts longer, then you will give them the permission to trip off.

So this graph represents the no trip zone. And it varies by system. We show NERC, so the North American Electric Reliability Council, HECO, that's Hawaiian Electric Company, the Puerto Rican electric power authority, the grid of Ireland, and then IEEE and international standards. So there's many different sects for this requirement. But the point is you can require your IPP to remain online during low-voltage conditions, high-voltage conditions, or even zero-voltage for a certain, limited amount of time. And you want to do that to prevent that cascading failure that would happen during severe under or over voltage periods.

Okay. Moving on to SCADA. So SCADA is Supervisory Control and Data Acquisition. This is something that doesn't apply to just electric utility

DRAFT

systems. SCADA systems operate for gas systems, for oil systems, for water systems. And the idea is that when you have a centralized dispatcher or operator or controller who needs to have visibility into flows basically at different geographic points on their system, then they do this frequently with the SCADA system. And so the SCADA's going to not only provide awareness of what's going on but also provide the controller or the operator or the dispatcher to pass a signal to the participants in that system and request them to do something else—higher or lower flow basically.

So the point with SCADA is to make sure it's in place but also to make sure that you have some redundancy of that communication system and that it's a high temporal resolution, so as close to real time as you can get. Because that will go a long way toward helping your system's stability. And you can also use SCADA systems to pass other information. So getting the communications protocol set up in advance and figuring out the best way to have that sort of two-way flow of information between the utility's central operator and the IPP is really important and certainly should be mandated in a PPA.

So moving on to the next slide. Forecasting is—it's sort of a different animal than the things we've just talked about in that it's not this kind of physical system stability requirement. But forecasting is increasingly necessary to optimize the system's flexibility to respond to solar and wind. So with forecasting, a system operator can know what's coming down the pipe in sort of the near term. And if they need to ramp up a unit to provide reserves for a potential decrease in variable generation or ramp down a unit, take something offline if they know they're gonna have a whole lot of free-ish solar and wind power—I say free-ish because of course there is some small O and M associated with wind and solar plants.

It's almost negligible compared to traditional thermal units, however. But with the forecasting, they can minimize their spinning reserves. There's a couple different names for reserves and a couple different categories. But point being if they can minimize that backup power that's put aside as reserves in case the wind and solar drop off, they can more economically take advantage of the wind and solar power. So in order to get good forecast of the power out—there's two different ways an operator can do it.

They can do it themselves basically—and maybe it's themselves. Maybe it's some outsourced service that they utilize. But by doing it themselves, they will need meteorological data points from the various wind and solar farms on their system. And pretty specific stuff. They're gonna need the wind speed and the irradiance; that's obvious. But they'll also need the humidity, the temperature.

And they need it at not just one point. Giving them a point of interconnection set of data points is not going to be nearly as useful as requiring that set of meteorological data points to be taken with geographic spread over the entire wind farm. And the same is true for solar because as clouds pass over, they're going to hit different parts of the solar arrays. And so if you're collecting

DRAFT

meteorological data, you want to require it at various points in the power plant itself.

And make sure you know, for example, what height the wind speed is measured at and these sorts of things. So they can take all that data, and again, they need their communication systems to be really fast. And they take that data at high frequency and as fast as possible, and they crunch it through an algorithm either themselves or someone else. And that will provide a power output.

Power outputs can be based on the power curve of the equipment, so that's another piece of your requirement in your PPA, is you want to get very detailed information on exactly what turbines they have running if it's a wind far or what sets of turbines. And same for the solar panels. You'll be needing to understand the maximum potential of those units based on meteorological conditions. Now, if that seems like it's a whole lot to do and you don't have the capacity staff-wise or the ability to outsource, you can require that those IPPs provide power forecasts themselves instead of just the weather data.

Say, "Okay, I need you to give me—you, Mr. IPP, your forecast of what you're plant's gonna be producing in the next ten minutes. And I want that updated every minute." Or however it is. But you want it specified for how that data is going to be passed back to the central operator. Okay, moving on. Oh, one other piece before we leave there.

Availability. So when you've got a power plant that's made up of many different wind turbines or many different solar panels, you're—it's not as if the plant is available or not available. You're gonna have some planned maintenance that's gonna rotate through the equipment. And then there's gonna be some unplanned outages. And you want to have knowledge of the availability of those pieces of equipment.

So again, that would be great if it could be passed in high time resolution. Okay, moving on to the next slide, ancillary services. We covered a whole bunch of them. Frequency response we didn't get into too much detail with respect to primary and secondary versus inertial. But those are sort of time differentiated frequency response requirements that help the grid. And we talked about voltage stability.

Reserves we mentioned briefly. And I just want to say that there is those spinning reserves, those sort of dynamic reserves, and then there's also the contingency type reserves, where this is in response to an unexpected outage. And again, this is an ancillary service for which you can either have some requirement on your system, or you can have some market based incentivization scheme. I feel like with ancillary services generally or grid services it's either the carrot or the stick.

You either require it in your grid code or your interconnection agreement or your PPA, or you incentivize it by providing some revenue stream based on that service provision. So there's two ways to go about it. And as we evolve with more renewable energy on the systems, I think we're seeing more market based mechanisms to bring those grid services onto a system. Black start capability, that's another ancillary service that doesn't get mentioned a whole lot.

But if there are blackouts and you need to fire up a generating unit from scratch, you need to have some source of power for the controls of that unit, some battery, some unit that can basically start by itself. And that’s a service that should not be neglected. Because that's gonna be the first way of getting your system back on. So with—if institutional incentives are not adequate, then, again, PPA provisions could be what you need to button up those services such that you keep your system stable and reliable.

Moving on to the next slide. Just a quick depiction of which of these types of ancillary services, wind and solar and batteries, can provide. So they can basically provide all of the ones that conventional generators can provide with respect to active power control, which is in response to frequency deviations. And then the reactive power voltage control. For mechanical inertia, which is the—again, a frequency response and super short time frame, wind can actually provide it even though it's not a synchronously connected generator.

It can provide it because it has kinetic energy in its rotor. So in a cell there's actual movement that kinetic energy can be borrowed from to increase the output of a wind turbine generator briefly to account for a frequency drop in the system. The wind turbine itself sort of has to pay back that power if it borrows from it. But again, sometimes it's reverted to a synthetic inertia, that sort of thing, where the wind turbine is providing that response.

But it's doing it through power electronics coming off of the physical kinetic energy of its machine. Okay, one more slide that, again, this is part of the frequency response type angle. But automatic generation control is used to provide a secondary frequency response. So what that means is as frequency moves, it does it in response to various full load on the grid. And within that time frame, you want the system operator to be able to tell which generator should sort of step up or step down the response to this variability.

So they do it through AGC, automatic generator control, which means that they are sending set points to generators, to the IPPs, to have the output get targeted to a certain set point. So we have a graph here that comes from Xcel energy. So Tara's company. She's gonna be up here shortly. That shows that Xcel accommodates a whole lot of wind on their system. And they do it through requiring AGC connections to their wind park.

And here we have this measure of ACE, which is the area control error. It basically means the difference between scheduled and actual interchange of power. But it's basically a measure of how closely you're hitting your supply/demand balance. And when the operator in the middle of the night here at 2:45 was seeing the ACE go high, that area control error go high, he requested the wind park to basically ramp down—so the blue line—come down off of the red line, which is that wind park's potential based on wind.

DRAFT

So the wind park came down using this AGC system to remotely and automatically adjust their output and got that ACE under control and then let the wind farm go back to their full potential there on the right side of that graph. Okay, so wrapping up here—so the key takeaway is non-synchronous generation will replace synchronous generation in time as we get more renewables on the grid. And the good news is that grid support services can be taken from those variable renewable generators.

It's helpful to require that at the inception of the project, just like if you're building a house and it's harder to go back and retrofit your electrical because you forgot you needed a kitchen outlet next to the toaster. This is what you want to do in advance. Specify the requirements. It'll be cheaper. It'll be clearer. It'll be easier for the parties to kind of kick off the commercial operation to a smooth start.

So the reliable, flexible power system operation can be achieved, but it, again, very system dependent. There is no one size fits all. And you'll need to consult with engineers, obviously, to get all of these measures really tuned in. And that's what I have. Okay. So I think we're gonna move right now to Tara Fowler from Xcel Energy to talk about Xcel's procurement of renewable energy.

Tara

Great. Thank you, Barb. Good morning, everyone. As mentioned, my name is Tara Fowler. And I am the manager of the renewable purchase power team at Xcel Energy. Today I will discuss what the US utility renewable procurement process and provide more in depth details as to what we include within our purchase power agreements, or PPAs. First, a little bit about Xcel Energy.

We currently have 3.5 million electricity and two million natural gas customers in eight different states. As you can see from the pie charts, Xcel Energy has a diverse energy mix. We are currently projected to have a 30 percent reduction in carbon dioxide emissions by 2020, based on our 2005 levels. Xcel Energy has been the number one utility wind provider in the US for 12 years.

You can see here the amount of wind capacity we have on our three largest operating companies, including the max hourly generation per megawatt, the max hourly percentage of load that wind has served, and the max daily percentage of daily load served. Hopefully from the numbers provided you can see that we've been very successful at integrating a large percent of wind onto our systems. Let's jump right into the renewable procurement process.

For the operating [inaudible] of Xcel, this process starts with a resource plan. The primary resource plan components include a current power supply mix, sales and demand forecast, projection of resource needs, proposed generation technologies to add, and a competitive procurement process or self-build. All of these components are utilized in a filing that is made with our regulatory bodies, the state public utilities commissions. The main objective of the regulatory filing is to take into consideration public interest as well as the commission's rules.

Those rules require that we maintain or improve the adequacy and reliability of the utility services, that we keep customer bills and utility rates as low as predictable, that we minimize adverse socioeconomic effects and adverse effects upon the environment, that we enhance the utility's ability to respond to changes in financial, social, and technological factors affecting its operation, and that we limit the risk of unforeseeable adverse effects. Once the resource plan has been completed, we file it with our state public utilities commission and enter into a two-track or two-phase process.

The first track or phase includes the resource plan filing. This is a litigated process where interveners can file a testimony in regards to the resource plan. The operating company can then file a rebuttal. The PUC will hold hearings. And then the commission will issue its final decision. Once the PUC has issued its final decision, the operating company can move to track two or phase two.

A request for proposal is issued to start a competitive bidding process based on the commission's initial decision. This competitive bidding process is where developers or other generators can bid in their projects to see if they are a best fit. The bids are evaluated during a 120-day bid evaluation period. The initial screening is an economic screening of those bids by the generators by technology based on a dollar per megawatt hour localized cost. This includes the transmission, as well.

Those bids that show the most economic value are then advanced to computer modeling program. Within the program, we develop a least cost and higher cost portfolios from those bids. We then come up with an estimate at the portfolio costs under various sensitivities. We come up with a select preferred portfolio. And then we report to the commission our end results.

This entire process, phase one and phase two, can take two years from start to finish. Once a final selection has been made, a purchase power agreement will be negotiated with those developers that have been selected. A purchase power agreement, as Barbara discussed, is a long-term agreement between the owner of the electric generating facility or the seller and the wholesale energy purchase or the buyer. A PPA allows the facility owner to secure a revenue stream from the project, which is necessary to finance that project.

Typically, PPAs address issues such as the length of the agreement, the commissioning process, the purchase and sale of energy and renewable energy attributes, price, curtailment, milestones and defaults, credit, and insurance. Typically a product developer will need an executed purchase power agreement to secure financing and will not begin to develop the site until they have an agreement in place. Our model purchase power agreement can be found online and is public. You can see the link to that agreement on the bottom of this slide.

Next I'll discuss the different components of the purchase power agreement that we use and how those components impact the buyer's and seller's development timeline. Once a PPA has been negotiated and executed, each party will be required to fulfill the conditions precedents and commercial

DRAFT

operations milestones outlined within the purchase power agreement. The conditions precedent is an event that is required before something else can occur. Using—these requirements impact both the procurement and development timelines.

I've provided some examples here, such as the buyer must seek state regulatory approval within a certain amount of days. And if that state regulatory approval is rejected, then that buyer must terminate within another set of days. Otherwise they raise their right to terminate the PPA. The seller will typically not begin to develop the site until the buyer has received state commission approval and the buyer has secured financing.

As Barb mentioned, most purchase power agreements are take or pay. Take or pay is a type of contract where the company or buyer pays for the product that is produced, whether or not it could've been taken or not. With that said, most PPAs recognize that there will be times in either the purchaser, the transmission owner, the transmission authority, may curtail the facility's production of energy because of constraints on the transmission system, emergencies, or other reasons. The parties must decide who will bear the financial risks for losses that arise when this happens. Often, the purchaser or the buyer will pay the seller for energy that the project would have produced as a result of the purchaser's ordered curtailment.

That is the way that deals get done. The buyer guarantees income so that the independent power producer or generator can get financing. Another piece of the purchase power agreement is defining the compensable and non-compensable curtailments. Compensable means curtailments that will be paid for, and non-compensable means those curtailments that will not be paid for. Typically for a compensable curtailment, if there are production tax credits or investment tax credits involved, they will be paid for, as well.

That again is to guarantee the project revenue so that they can secure financing. Some examples of non-compensable curtailments, meaning curtailments that will not be paid for, would include an emergency, an action taken under the interconnection agreement, a restriction or reduction of transmission service, the seller's failure to maintain full force and effect their permits to construct and operate the facility, and the seller's failure to maintain automated generation control capability. Compensable curtailments essentially would be covered under anything not listed as non-compensable. Again, that's the way that the deals get done. The buyer guarantees income so that the IPP can get financing.

The purpose of negotiating and executing a purchase power agreement is to address the different risks that the buyer and the seller may have. Here are a few examples of those risks that the buyer and seller may take. For the buyer, there are market risks in place. There's a wholesale price risk. That would mean that the buyer could have purchased power from another source that would be cheaper than what they've locked in for the purchase power price. There are forecast risks, where the buyer may need to put in a forecast.

DRAFT

DRAFT

And if that forecast is deviated from, there may be penalties associated with that. There's also congestion risk, where there may not be enough load to serve at the point of delivery. There are reliability risks, where the costs or expenses associated with the variability of the intermittent resources, especially for wind or solar, that they may have to pay penalties associated with that. There's also regulatory risks, where the regulatory body, such as the public utilities commission, could determine after the fact that this is not something that they see as a valid project anymore.

Different types of seller risks include performance risk, such as the equipment that they've purchased has failed or is underperforming. There's also construction risks, where they may miss their deadlines because their construction provider isn't meeting their deadlines. There could be transmission outages from where the project is generating to the point of delivery. Then there's also meteorological risks.

Barb alluded to some of these, where maybe there's a low-wind year if it's a wind resource or there's cloud cover for solar, making it so that you're not able to produce your goals. In the next few slides, I'll discuss how some of these risks are mitigated within the terms of the purchase power agreement. Sellers and purchases face risks associated with the credit of the other party. Many purchasers require sellers to provide some form of credit enhancement to cover expected damages to the purchase if the project does not meet construction milestones or is not commercially operational by the agreed upon date.

This credit enhancement could take several forms, including guarantees by credit-worthy affiliates, cash collateral, or escrow accounts, irrevocable standby letters of credit, or performance bonds. The PPA will usually require that seller maintain at the seller's expense specific insurance policies, as well, and name the purchaser as the additional insured. The buyer will also typically require the seller to guarantee that the project will meet certain performance standards. Performance guarantees let the buyer plan accordingly in developing new facilities or when trying to meet demand schedules, which also encourages the seller to maintain adequate records.

In circumstances where the output from the supplier fails to meet the contractual energy demanded by the buyer, the seller is responsible for attributing such costs. Maintenance and operation of the generation project is the responsibility of the seller. That includes regular inspection and repair to ensure prudent practices. Liquidated damages can and will be applied if the seller fails to meet these circumstances.

Typically the seller is also responsible for installing and maintaining a meter to determine the quantity of output that will be sold. Under this circumstance, the seller must also provide real time data at the request of the buyer, including atmospheric data relevant to the type of technology used. These requirements in the purchase power agreement, as you can see listed above, will help us, the buyer, to ensure that we can integrate the wind or solar or whatever resource onto our system. As you can see, these are many of the things that Barb discussed, such as the automated generation control, data collection, and forecast of turbine availability.

Some key takeaways. The renewable procurement of an investor owned utility, an IOU, is a regulated process. Buyers must guarantee income so that the seller can get financing. Again, that's how deals get done. The purpose of negotiating and executing a PPA is to address who takes what risks. Next, I will pass it on to Ilya so that he can answer any questions or moderate any questions that you may have.

Ilya

Thank you, Tara and Barbara, for those excellent presentations. We'll now move on to a question and answer session. So please, if you have any questions for the panelists, submit them through the question box in the GoToMeeting platform. First I'd also like to mention that you can go to http://www.greeningthegrid.org for additional resources and webinars on other grid integration topics. We have a two-page facts sheet that you can find there on power purchase agreements and other topics, as well.

So our first question is for Barbara. Can wind turbines be retrofitted to provide grid services? So for example, would it be costly to add frequency ride-through capability to an old wind plant? And is this common?

Barbara

So yeah. They can be requested to provide those services retroactively. Really, most of these—they're power electronics. And in fact, it's a question of, in a lot of cases, software or maybe firmware and not even hardware. I guess it depends on how old the system is. But in recent years both solar and wind have capabilities that are—they need to sort of be modified and set up through control and algorithms, but it's not hard physically.

Wind is a little bit harder than solar. There are packages, though, on turbines. If you go to GE, buy off the shelf turbine, you can upgrade to get these packages. So if you want to do it retroactively, it's just a question of negotiating that price with the turbine manufacturer. And is it common? I don't think it is very common actually. As systems get more and more renewable energy on their—in their portfolio, they can rely on those services from the existing thermal units.

Or as they get new ones they can request the new ones to provide the services. So I haven't seen much where they have to go back and say, "Okay. Go ahead and install that." And then that certainly would be a question of who pays?

Ilya

Thanks. And the follow-up question to that is for Tara, actually. And that's about how easy is it or difficult is it to renegotiate a PPA to include requirements for grid services that weren't in the original agreement? And do you have any strategies to support those kinds of negotiations?

Tara

Sure. So it's actually typically very difficult for us to renegotiate a PPA. For us it's a very regulated process. And so either the model PPA itself has been approved by the public utilities commission or once it's negotiated we have to

DRAFT

take it to the commission and have it approved. It depends on which state we're operating in.

So if we want to open up the purchase power agreement to renegotiate terms, we end up having to go through the entire regulated process again. Now, we can do things such as amendments and make additional filings for those if it's not something that's a material change. But if it becomes a material change, then it becomes a much longer process. I will say that's happened in the past.

And typically what happens is we need to figure out who's gonna have to pay for what costs. And typically we'll—it brings both parties to the table. And we'll figure out, okay, well, if we're gonna bear these costs, what are we gonna get in return? And vice versa?

Barbara I—if I can add to that, Tara, I imagine it's also a problem for the IPP with respect to whoever's holding their debt. The investment bank who owns part of that project, at least in the first ten years if you're in the US and you're trying to monetize a PTC, they have a seat at that table, too. And just like your bank, if you don't own your house outright, your bank sort of has a seat at the table if you're undergoing some big changes.

So it just gets complicated with respect to the number of parties involved and that renegotiation.

Tara That's absolutely right. And that's actually a challenge that we face within the negotiation of the purchase power agreement itself. So you come to a table to negotiate. And we consistently have to rely on our public utilities commission and what they're gonna allow. And then the IPP or developer has to rely on what their financier or the tax equity partner will allow them to do, as well.

So we have to figure out—the buyer and the seller have to figure out what both of their interested parties are going to allow and come to an agreement based on that, not just what they want, as well.

Ilya Thank you. So we have many great questions coming in from the audience. And this next follow-up question is for Tara. It's about the main considerations that you look for when awarding bids for a PPA. Is price the main consideration, or are there other criteria, as well?

Tara Price is definitely king. Our responsibility is to get the least cost projects for our customers because we pass those costs onto them. And we don't want their electricity bills to raise [inaudible] that as can hold as much as we can. With that said, we have to have a reliable counter party. So we need someone that we can do our due diligence on and understand that, okay, they're gonna be able to get financing once they have a purchase power agreement. Or they're gonna be able to get the turbines they need or the solar panels they need within the time required to get the project built.

Because the hardest part is having to go back after the fact if a project fails and negotiate with another counter party. And then you're out one, two,

DRAFT

potentially three years. So price is definitely king. But the counterparty and the reliability that they can provide is definitely second.

Barbara

I can comment on that also because I do some projects in the Caribbean. And it's amazing how many bidders come in and throw in a price that is low, and they don't account for the difficulty of getting the equipment to some of these islands, that whole supply chain of shipping in panels or shipping in turbines. This sort of thing is more difficult than a lot of them reckon. And the utility of course are obligated to the PUC and their customer base to go with the low bid.

And then they get hung up because they can't get the project built. Or it's so low that they're not able to get it financed. And like Tara said, it sets you back a year, two years, three years. So my advice is to go with the best value. And maybe go through a pre-qualification type requirement for bidders to make sure that they are being realistic, that they have experience, that they can really see that project through to fruition.

Time is money, and if you set back by a year or two and have to renegotiate it again with a different part, it just—it doesn't benefit anyone.

Tara

Yeah. And I would continue to add to that. We do have a pretty extensive due diligence process for those exact reasons. So when we go through a request for proposal and our bids come in, before we even look at price we have all of our different subject matter experts digging through those bids, making sure—are they gonna be able to get their interconnection agreement in time? Are they gonna be able to interconnect to our system?

Have they got the right transmission costs within their bid? Because especially working with regional transmission operators, RTOs, there are some times where they have to go through another transmission provider to get to the ISO or the RTO themselves. And they don't realize that. So we try and do a lot of that due diligence ahead and ask a lot of questions to make sure what they're—what they've put in their bid is realistic and is manageable.

Ilya

Great. So this next question is again for Tara. It's about Xcel's model PPA and whether you've found that having a model PPA has actually reduced the cost of obtaining a PPA with a seller.

Tara

It has been. And we should actually have a revised version that will be out here within the next couple of months, which will reflect some of the changes we've made over the last three, four, five years. We—when we go through and update our model, we're very cognizant of what it takes for the seller to get financing and to get tax equity. And we also take into consideration what risks we're willing to take and what risks we're not willing to take. Because if—we don't want to put our customers at any sort of risk.

So by putting that into a model and saying, "Here's the starting point," and we've already run to ground most of the things that they're gonna need as well as what we need, it makes the negotiation process a lot shorter. It makes us both come to the table, and it shows that we recognize what their needs and wants are. And it gives them an opportunity to see what our needs and wants are. So it makes it a much smoother process.

I've heard that a lot of other companies use our model PPA. And they will occasionally call and ask questions about the PPA itself. Because they're gonna use that same model in their negotiations, as well, and maybe make a few changes to reflect what they need.

Barbara And it's also provides apples to apples. You need to make sure that the developers are bidding to the PPA so that when you compare the prices across, you know what you're getting.

Tara That's absolutely right. And when we do our request for proposals, we'll allow them to make exceptions. And that's part of our due diligence process. We'll go through those exceptions. And if they've done something like they've said they would like to reduce the security, well, that's a non-starter for us. So we can reach out to them and say, "Hey, we noticed that you can't pay this security level or you don't want to.

This is something that's required by our risk department. We don't have a choice. Do you need to reassess your bid? Do you need to change the price of it? Or are you still willing to participate in this process?"

Ilya Great. Thank you. So we have several questions coming in about the impacts of wind on Xcel Energy's grid and also on the prices for consumers. So I think the next question will be about the price impact that you've seen in Xcel Energy's territory. How have rates increased or decreased or stayed neutral over the last several years as wind has increased?

Tara I'm not necessarily sure I'm the most qualified person to answer that question, but I want to make sure I understand it. So is the question has the cost of wind itself decreased? Or the cost of wind once you consider congestion or curtailment?

Ilya So I think the question is referring to the cost for consumers of—in Xcel Energy's territory. So electricity rates for end use consumers.

Tara Sure. Okay, actually, I think I can answer that question. So one of the big initiatives that Xcel Energy has right now is called filled for fuel. And this initiative started with clean power plan. But we actually, even with that being dismantled, are—we want to be a very green company. And we're very responsible when it comes to—or I think our—it's responsibility by nature and nature by responsibility, something along those lines.

But that's definitely one of our key drivers for our company. So what we've started to do is as we've been decommissioning our coal plants, we've been saying we want to replace that with low-cost renewables. So a utility earns money by putting projects into rate base. So as we remove coal from our rate base that we would otherwise have to put scrubbers on or have to put additional equipment in to clean it up or to keep them running or prolong their life—because some of them are coming up to retirement age—what we've been doing is replacing that with wind and solar.

Solar is a non-peak resource. It's gotten much cheaper. It still doesn't beat coal or natural gas. But because it's during peak hours it's starting to become more price competitive, especially with the capacity factors that are involved. And then wind, especially within the eight states we're in, we're definitely in a strong wind penetrated area, the wind is cheap. And it's coming in. It's beating natural gas prices.

So as we're removing coal from our rate base and putting wind and solar in, we're lowering the cost for our customers.

Ilya Great. Thank you for that answer. So we've got time for a couple of more questions. This next question is for Barbara and possibly for Tara, as well, based on your experience. Are PPAs that require ancillary services more expensive in general than those that do not?

Barbara Yeah. I think that with all else being equal if you require extra services, then you're gonna pay—like the example I gave before with respect to the package—the add-on package that GE provides for some of these controls. It's just like when you buy a car and you get the leather seat option. It's a bit of an upgrade. Certainly a lot cheaper to do it from the get-go. But if you require it—and again, model PPA or at least a specified requirement on the front end, you get apples to apples.

Then the developers can bid that in, that sort of extra feature into their price. And it won't be much more. It's—they're very cheap. Again, the power electronics components are very cheap relative to any sort of mechanical providers of those services.

Ilya Thank you. So this last question is for Tara. And it's about the risks of natural calamities. So suppose a wind turbine is broken during a storm. So who takes the responsibility for that damage? Is it the seller or the buyer?

Tara That's a really good question. So for natural calamities, we list that as a force measure within our purchase power agreement. So what that essentially will do will allow the developer to fix the project without it impacting their committed energy requirements. With that said, they also—so we take that risk because we're not getting the energy that we're relying on.

However, in a force measure event, the developer doesn't get paid for what could've been produced because there's nothing that they can produce. The turbine's on the ground or blown away. So it's a shared risk between both parties, but it's one that doesn't have any sort of damages associated with it.

Ilya Great, thank you. So we do actually have time for a few more questions. And we've gotten a lot of questions about wind, but we also have some questions about solar. And the next question is again for Tara. Does Xcel Energy have a model PPA for solar? And does it require any grid support services from its solar energy plants?

Tara That's a really good question. We do have a solar energy purchase agreement. The model agreement that's online is almost essentially the same. The only things that change are rather than wind, it's solar, the different type of equipment that we require. We do require grid services. And honestly, I think from a solar perspective it's probably a little bit easier.

You don't—you have the—you have intermittency, but it's a little easier to control for us right now because we don't have the same penetration of solar on our system that we do for wind. So I guess I should caveat that with it seems easier now, but as we add more and more solar, we may have to tighten our restrictions and require more good services within our projects. But as of right now, it's fairly basic. And the agreements are nearly the same.

Ilya Great, thank you. So the next question, again, it's for Tara but also for Barbara based on your experience. For both wind and solar PPAs, do you find that it's better to have a long-term PPA or to also allow in parallel or following a short-term PPA for wind and solar plants to participate in an open wholesale market?

Barbara Again, from my experience, in order to minimize the finance cost, it makes more sense to have a long-term PPA. There are certain—I see certain deals that happen or consecrate example, where IPPs go—what I call going merchant, where they're just playing the market. Or they do kind of a stringer contract, where they might have a ten-year obligation. And then they can fly free with respect to the wholesale market.

Another creative way to structure a contract is to do some portion of the generation as a fixed rate PPA and then allow the IPP to either take the risk of the rest of the balance of the generation on the wholesale market or let the utility buy. So there's lots of ways to kind of collar that price risk. But I think in terms of minimizing finance, again, long-term PPA makes more sense.

Tara And I would second that. Most of our developers, the longer the purchase power agreement they can get, the better for them. Especially production tax credits those first ten years are key. And then they want to continue to be a viable project. And our PPAs are all done at a fixed price rather than a variable cost or an LMP, a locational marginal price. So they can guarantee those revenue streams, which I think makes it much easier for financing.

Now we've got—we've seen in the industry a lot of CNI customers who want to do ten to 15 year purchase power agreements to purchase from the developer. And I think the developers are starting to kind of recognize that if they want that type of business that they're gonna have to do the shorter timelines. But I definitely think their preference would be to do something along the lines of with the utility where they have that 20 to 30 year guarantee.

Ilya Great, thank you. That's really helpful information. This next question is a quick question for Tara. Do you—does Xcel require AGC on all its new wind plants? And do you find that this is a requirement on new contracts?

DRAFT

Tara Yep. So we do require AGC on all of our new contracts. And we've found ourselves in a position more than once where we're operating in MISO or SPP, and they've gone back and required us to get AGC on projects that previously were not required to. So some of our original purchase power agreements that wasn't a requirement that was in place. And now the RTOs and ISOs that we're operating in are now requiring it.

So we're—that's—kind of goes back to one of the original questions, where we actually had to go back and ask that. And everybody has to come to the table and figure out who's gonna bear what cost and how can we make it fair for everybody. But yep, going forward all of ours have AGC protocols. They also have requirements for data collection.

So for example, for solar we require that they provide different sorts of meteorological information, such as the solar insulation or the solar intensity, the temperature, the inverter availability in their generation. That way we can forecast based on that. And then for wind we also include wind speed, wind direction, and the barometric question.

Barbara So Tara, this is Barbara. If I can ask you a question. Now, when you're running a plant on AGC and you're pulling it down—so you're—say you're load following, and you need to decrease. Are you paying—are you calculating the park potential and paying them for what they could have produced?

Tara Yes, that's exactly right. Unless it's one of the non-compensable curtailments I discussed. So unless it's for an emergency or reliability or the transmission authority requiring us to do it, essentially any other reason that we're backing down, such as congestion or any sort of economic curtailment, the difference between the park potential and that AGC set point is what we calculate as the—a compensable curtailment. And then I—so I mentioned it very quickly. But if the project has production tax credits in place, so for the first ten years, not only do we pay the amount for the energy, but we also pay for the production tax credit—I cannot say that, I apologize—the production tax credit that they would've received, as well.

Barbara On a gross-up basis, I presume, for anybody who wants to get in the weeds.

Tara Yeah. Thank you for that.

Barbara Yeah. Not just the value of the credit would be grossed up for the income that they would've had to have netted the credit against. So.

Tara Yep, that's exactly right.

Ilya So our next question—and this might be the last question—is for both Barbara and Tara. It's about requirements for different—systems of different sizes. Sorry. So we know that Xcel Energy has a very large amount of wind power, 17 percent I think for the year last year. What about systems that are just beginning and that are just starting out? Is it necessary for PPAs in a new industry to require grid services?

DRAFT

Barbara No. I don't think it is. If you've got some smaller CT, some flexible—whatever they are—flexible generators on your system, it might behoove you to rely on those traditional generators to provide the grid services. Having said that, it's really cheap for the wind and solar to have the capability. So a lot of times you go and put the requirement that they have the capability, but you don't sort of turn it on until down the road when your system has higher penetration of variable renewables and you need potentially to call on those services. What do you think, Tara?

Tara Yeah. I've always worked with a very large utility. So for—our big thing has definitely been integration and how do we add this much wind penetration to our system and followed by solar. So it's definitely extremely important for us. In a smaller system, I agree. I can't imagine that the same services would be required. With that said, as things evolve, it could eventually be a requirement. So the same thing for our organized markets, where previously it wasn't a requirement, they're asking us to go back to projects the size one megawatt, five megawatts, and ask them to start providing these services.

So I think it may not be required right away, but as the market matures it's something that the organized markets will start to require. And like you said, I think it's very cheap for these things to be added. I think a lot of it's part of the standard package, at least in the US now. Because so many people do require it that I think that it—the additional costs for that—the incremental cost is gonna be very minimum.

Barbara Yeah. And take as an example forecasting data, the meteorological data or the provision of that data. Even if you as a utility aren't gonna use it for a while because—for example, I have one project I'm working on where the country is going through blackouts continually. They don't have enough power on their system. So they're not trying to optimize their spinning reserves. They have no reserves. Everything they have is running flat out.

But still if they're setting up a new wind or solar, it makes sense to go ahead and request the data—the meteorological data that we're talking about, even though they're not gonna be really utilizing that data until they get kind of a beefier system and a better supply/demand balance. But it's easier to put the requirements in place now contractually than to have your counterparty extract money from you when you request it down the road.

Ilya Great. Thank you. I think this was an excellent conversation. Thank you to all the participants for your excellent questions. We—there were way more questions than we were able to cover in the time that we have. If you do have questions that you'd like Barbara or Tara to answer, please feel free to e-mail them. Their contact information is posted on the slide that you see now. And we'll work together to answer your questions.

Also, I'd like to encourage you to visit http://www.greeningthegrid.org for more materials and for additional webinars and for upcoming webinars on grid integration issues. Thank you all for joining.

DRAFT

Katie

Great, thank you again. And on behalf of our Clean Energy Solutions Center, I'd like to extend a thank you to all of our expert panelists and to our attendees for participating in today's webinar. We very much appreciate your time and hope in return that there were some valuable insights that you can take back to your ministries, departments, or organizations. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including no-cost policy support through our ask an expert service.

I invite you to check the Solutions Center website if you would like to view the slides and listen to the recording of today's presentation, as well as previous held webinars. Additionally, information on upcoming [inaudible] and other training events. We also—we are also now posting webinar recordings to the Clean Energy Solutions Center YouTube channel. Please allow about one week for the audio recording to be posted.

Finally, I would like to kindly ask you to take a moment to complete a short survey that will appear when we conclude the webinar. Please enjoy the rest of your day, and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.

DRAFT