CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Utility-Owned Distributed Generation Models

—Transcript of a webinar offered by the Clean Energy Solutions Center on 6 March 2019—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

Katie Contos	Moderator
Riccardo Bracho	National Renewable Energy Laboratory (NREL)
Doug Gagne	NREL
Daniel Haughton	APS
Kerry Klemm	Xcel Energy
Christopher Bilby	Holy Cross Energy

This Transcript

Because this transcript was created using transcription software, the content it contains might not precisely represent 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 utility-owned distributed generation models. Before we begin, I will quickly go over some of the webinar features. For audio you have two options: You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the "mic and speakers" option in the audio pane. If you want to dial in by phone, please select the "telephone" option and a dial on the—a box on the right side, excuse me, will display the telephone number and audio PIN you should use to dial in.

If you'd like to ask a question, we ask that you use the question pane, where you can type it in. You can do that at any time during our webinar. 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 to 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 features in the Solutions Center's resource library as one of many best practice resources reviewed and selected by technical experts.

We have a wonderful panel organized today and they will explore the various business models for utility ownership of distributed PV generation, including

utility-owned community solar, utility rooftop PV programs, and utility DG facilitation services. And before we jump into those presentations I'll provide a quick overview of the Clean Energy Solutions Center. And then, following the presentations we'll have a question and answer session where the panel will address questions submitted by you, the audience. At the end of the webinar you're going to be asked 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. Twenty-four countries and the European Commission are members contributing to 90 per cent of the clean energy investment and responsible for 75 per cent of the global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which is an initiative of the Clean Energy Ministerial. The Solutions Center focuses on helping government policymakers design and adopt policies and programs to support the deployment of clean energy technologies. This is accomplished through the support and 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 cosponsored by the governments of Australia, Sweden, and the United States.

The Solutions Center provides several clean energy policy programs and services, including a team of over 60 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, and partnership building with development agencies in regional and global organizations to deliver support, and an online library containing over 2500 clean energy policy-related publications, tools, videos, and other resources. Our primary audience is made up of energy policymakers and analysts from governments and technical organizations in all countries, but we also strive to engage with the private sector, NGOs, and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across a suite of different programs. Several of the partners are listed above on this slide and include resource organizations like IRENA and IEA, and programs like SEforALL, and regional-focused entities like ECOWS Center for Renewable Energy and Energy Efficiency.

A marquee feature the Solutions Center provides is a no-cost policy expert known as Ask an Expert. The Ask an Expert services matches policymakers with more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics—excuse me. For example, in the area of distributed generation we are very pleased to have Ryan Cook, a senior associate at Cadmus serving as one of our experts. If you have a need for policy assistance in distributed generation 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 online format scheme, energysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations.

Before we begin with our panel today we'll have a brief overview of the DG campaign by Riccardo Bracho, who is a Senior Project Leader at NREL. And now, I'd like to provide an introduction to our wonderful panelists that we've gathered today. First up, we have Doug Gagne, who is a Project Analyst at the National Renewable Energy Laboratory, NREL. He currently provides early state federal project development support for renewable energy and resilience projects. Following Doug we'll hear from Dr. Daniel Haughton, who is a Manager of Distribution Energy and BER Interconnections at Arizona Public Service. He is an advisor with EPRI and NREL technical advisory committees on DER interconnection practices and distribution planning modernization.

Then we'll hear from Kerry Klemm, who oversees the implementation of Xcel Energy's renewable choice programs across seven states, including the nation's largest community solar program, private solar interconnection options, and green pricing programs like Windsource and Xcel Energy's latest innovation in renewable choice programs, Renewable Connect. And our final speaker today is Christopher Bilby, who is a Research and Programs Engineer at Holy Cross Energy, a not-for-profit, member-owned electric cooperative utility providing electricity, energy products, and services to more than 43,000 member in Western Colorado. Christopher supports the power supply department by studying and planning for increasing numbers of distributed energy resources and their effects on system load and load profiles.

And with those brief introductions, I'd like to welcome Riccardo from NREL to provide a brief overview of the DG campaign.

Riccardo

Thank you, Katie. As Katie mentioned before, the Clean Energy Ministerial you already heard about, and then the Clean Energy Solutions Center is an initiative of the Clean Energy Ministerial. As well, we have a 21st Century Power Partnership. The 21st Century Power Partnership is an initiative to advance integrated policy, regulatory financial and technical solutions for large-scale deployment of renewable energy in combination with energy efficiency and smart grid solutions.

Within the 21st Century Power Partnership, last year the Clean Energy Ministerial meetings in Denmark, Mexico launched a distributed generation campaign. The distributed generation campaign—all the campaigns for the Clean Energy Ministerial are typically a 12-month campaign. And in this case it was launched by Mexico and supported by a host of other countries, including India, Denmark, Germany, Chile, and Brazil. The distributed generation campaign was called for strategic regions. Although most of the work has been targeted to the region of Latin America, it applies to basically a lot of other regions in the country, and the campaign will start working in Southeast Asia and other regions of the world in the next few months.

The objective of the campaign is basically to assist developing nations to accelerate the deployment of clean distributed generation technologies based on sound economic and public policies, appropriate regulation, and advanced technical solutions. Under the distributed generation campaign we have had already some activities, including a needs assessment document from the Latin America region, and we have hosted already a structure with 15 members of 11 different countries in the United States that came to Colorado, Arizona, and California to learn about policy regulation and the newest technical research for distributed generation.

So, the next activities that we have are these two webinars. The first webinar 0is the one that you'll see today on the DG utility-owned models, and also some community solar, which were two very important topics for the members of the campaign. And in the near future, perhaps next month, we will have another webinar on technical issues. Thanks, Katie.

Katie Thank you, Riccardo, for that overview. Now, I'd like to welcome Doug Gagne from NREL to continue on with more information.

Doug Hi there. So, yeah, this is Doug Gagne with NREL. I'm going to give you all a brief overview of some of the models that we'll be discussing today in the utility-owned distributed generation space. To give you an overview of the agenda today, I'll be giving that brief overview discussing some of the background on these business models so that you have a little bit of baseline for the case studies from three different utilities that are pioneering these business models in this space.

So, today I'll give an overview of three different emerging utility-owned business models and kind of a fourth that I'll talk about a little later. These distributed PV generation business models don't have to be utility-owned. They could also include customer-owned projects, projects owned by third party companies who can use available tax incentives, and the utility-owned investments that we'll be discussing today. This webinar will focus on utility-owned projects, specifically such as rooftop leasing, utility-led community solar, and a utility distributed generation facilitator model. So, I'll first give an overview of each of these modules, and then our case study presenters will discuss their experiences with them in more detail.

So, the first model that we're going to unpack a little bit is rooftop leasing. So, this is utility-owned distributed PV—or DPV—systems. They generally involve a fixed payment from the utility to the homeowner for the use of their roof, while the utility owns and operates the DPV system to their benefit, and they can also control the asset. Some examples of this type of rooftop leasing in the United States include the state of Arizona with APS and Tucson Electric, as well as California with the Los Angeles Department of Water and Power. In both of these instances the utility pays the homeowner about $30.00 a month for 20 years in return for the ability to lease their roofs and install a utility-owned PV system. The electricity generated from these systems is then fed directly into the electricity grid and controlled directly by the utility.

A slightly different model implemented by Tucson Electric is instead of a roof rental program the homeowners agree to pay a fixed dollar per kilowatt charge per month in exchange for the solar electricity generated by the PV system, and so it's more similar to a solar lease program.

Some of the benefits of this approach is that in an investor-owned utility model in the US these assets can be included in the utilities rate base and drive financial growth. They also can provide operational benefits. Since the utility can choose what customers to reach out to, they can focus on congested areas and potentially defer transmission and distribution upgrades as well as provide local voltage support for the grid. The generation diversity benefit is, again, that the generation is more distributed, potentially increasing the resilience of the system somewhat.

Some of the downsides of this approach are that instead of doing a large, ground-mounted, multi-megawatt system, the utility has to install the assets on rooftops, which tends to be more expensive than ground mount systems. It requires upfront capital investment, since the utility is purchasing, owning, and operating these systems. There's other—there can be other developers in this space, such as third party solar owners. And the regulatory structure is critical to the enablement of this type of process.

Moving on to the second model that we'll discuss today, community solar, there's a few ways in which utilities can develop their own community solar projects. The one that we'll discuss today is that the utility can finance, build, and own the underlying PV system, rather than entering into a power purchase agreement or having a third party, private company develop a community solar array on their behalf. So, in this case the utility can build the community solar program around the solar electricity and offer subscriptions to its customers. To date, as an example, there are more than a hundred utility-led community solar projects in the United States, and this model works where the utility owns the solar array and sells subscriptions to the community solar system.

They can be structured in many different ways. And one of their chief benefits is that they can allow customers who otherwise couldn't participate, potentially because they had old roofs or shading concerns or potentially couldn't afford the upfront costs of solar installation, to participate in solar. This is also a very promising utility-owned method for including low and moderate income solar customers into the benefits of solar because the community solar involves subscription shares. What some pioneering utilities have done, such as Holy Cross, is actually incorporate low and moderate income subscribers into their community solar arrays and provide an economic benefit to those customers while still providing solar benefit to other members of the community, such as businesses or nonprofits or homeowners from other non-low-and-moderate income backgrounds.

So, the way that these generally work is that subscribers will purchase a share of the total energy. This can either be an upfront payment or a monthly payment pay-as-you-go model. It really depends on the appetite of the utility and how they want to structure it. This is a very flexible model that has been

implemented in a lot of different ways and regulatory contexts. It is facilitated by regulations and legislation. Particularly, virtual net metering regulations can be very helpful for community solar to be developed. And these are also known as solar gardens or shared solar, and those are kind of synonymous terms.

Finally, I'll just give a brief overview of an even more nascent utility-owned model, which is the facilitation business model. So, residential customers are obviously at a disadvantage during procurement. They aren't solar experts. They're just given quotes that can sometimes have large escalation assumptions within them, and it's not always easy for homeowners to unpack all of the assumptions within a solar bid that they receive from a third party solar vendor. So, the benefit of a utility stepping in is potentially providing a platform for both customer—buyers rep, customer advocacy, as well as acting as a clearinghouse for both homeowners and third party solar developers to connect, and both defray the cost of customer acquisition—which is one of the major challenges for soft costs for third party solar developers of distributed PV—as well as protect buyers by providing a fair and equitable platform.

So, in these types of models the utility can develop a connection platform where they connect—they aggregate or connect customer interests with third party solar, or potentially utility-owned solar as well, if there's a rooftop leasing model in play. There's many different avenues—and this is still a nascent business model. So, some utilities that are starting to pioneer this are Georgia Power Corporation in Georgia with a platform, but there's still many opportunities for development. So, something that we wanted to highlight but something that's still fairly nascent.

And finally, the last piece that I just wanted to note is that another way that utilities have been participating in distributed PV is by—rather than installing systems under their own corporation—investing in existing third party-owned solar companies, as well as investment funds that invest in solar companies. This investment's been nearly $3 billion since 2010, and utility-affiliated companies have made investments in investment funds such as in ConEd, Georgia Power, where investments in entities such as—partnerships with entities such as Sun Power or development of new facilities such as the Georgia Power Energy Services Company have allowed these utilities to start engaging in this space, both from the utility side as well as through their ownership of a private corporation that's developing solar as well.

And for future reference here's also some lists of some different resources that can be accessed to learn more about these topics: overviews of community solar, DG business models, the community service scenario tool, which is a webinar that breaks down some of the different ways to develop these projects, and so on.

So, with that overview I will hand it over to Daniel with APS to unpack some of the great work that they've been doing.

Katie Daniel, your screen looks wonderful but we are not getting any audio right now.

Daniel Okay, can you hear me okay?

Katie Yes, now we can. Thank you.

Daniel All right. So, today I'll be going over APS—an overview of APS, what the utility looks like, resources we have connected, some of the challenges we're looking towards, and how we're going about solving it. I'll give you a brief introduction to the utility scale solar projects that are interconnected on APS' system and a really quick rundown on some of the ownership models as it relates to that. But really, I'll focus in on the residential and commercial distributed generation deployments and the examples of rooftop leasing that Doug had alluded to.

So, what is APS? So, APS is the largest investor-owned utility in the state of Arizona. We cover 11 of Arizona's 15 counties, 1.2 million customer meters, about—almost 3 million people. We're quickly growing service territory. Maricopa County, which is the bulk of our load, around the Phoenix metro area, has historically been one of the fastest-growing counties in the country over the last decade or so. And we have a system peak of about 7350 megawatts. So, on the map here our service territory covers all the gray shaded regions. So, you can see there's pockets that are disconnected from the main area of our service territory, so it's not one contiguous service territory.

All right. What is our resource diversity? How do we meet our system peaks? Natural gas is our primary, most abundant fuel source, followed by coal. We've got three large plants—or, output from three large plants across the state, primarily in the north or northeastern corners of the state. And we have a significant chunk of renewables connected within the state of Arizona, mostly from solar. There's about 100 megawatts of wind. We also are the co-owners and operators of one of the largest nuclear plants in North America, the Palo Verde Nuclear Generating Station.

Other elements of our resources include contracts. So, we import quite a bit of our energy through our peak periods. Energy efficiency accounts for a significant chunk of our resources. We've got two more recent micro grids that are also really interesting projects in terms of ownership—or co-ownership, rather, where they're built on customer sites but APS is a part owner of those systems and there's a cost and an output allocation for the micro grid sites. Then, we have a small amount of demand response.

So, in terms of renewables, the breakdown of our renewables looks like about 300 megawatts, almost 300 megawatts of wind, 200 of which is outside the state of Arizona—it's located in New Mexico—that's imported. But the story to tell here is really the utility scale solar. So, there's roughly 250 megawatts of utility scale thermal from a single large plant, the Solana Generating Station, and about a dozen or more utility scale PV plants that total about 230 megawatts. We also have a significant slice of commercial solar, about 300, 320 megawatts, and over 700 megawatts of residential distributed generation.

The majority of those commercial and residential installations are customer-owned. And the growth rate of the residential applications particularly is growing significantly. We're adding over 100—between 100 and 150 megawatts per year over the last few years in residential installations, and that pace is expected to continue into the near future.

So, where does Arizona as a state rank relative to solar production? Arizona, based on recent information extracted from our Energy Information Administration, is third nationally for PV production. APS, in specific, is the second highest large utility for residential installations per customer, behind PG&E in California. We're the fifth highest solar PV installed capacity of all utilities nationally. And on a population-adjusted basis, we are also third, ahead of California, behind Utah and Nevada, for PV production.

So, our utility scale solar plants at APS are listed on this slide here. The majority of them are a combination of purchase agreements—so, third party vendors contracted to build the site and APS purchases the power, purchases the output. A few of them are owned and operated by the utility. And one in particular, Red Rock, was a partnership between some private entities within the state of Arizona. Instead of building on customer property, this large solar site was built remote to the customer's facilities, connected to APS distribution and transmission, and the output of that is credited to the customer. More details can be found at the link that will be provided with the slides.

For distributed solar PV, APS has over 90,000 residential rooftops, growing at a rate of about 12,000 to 15,000 per year, which accounts for over 700 megawatts, as I mentioned before. For commercial we have about 1500 commercial systems. So, commercial could be anywhere between 200 kW and about maybe 5 megawatts, and that amounts to over 320 megawatts of commercial scale systems.

For APS-owned distributed solar, there is an APS Schools and Governments Program which is probably approaching about 7 to 10 years now, with 300 sites installed on school parking lots, playgrounds, rooftops. And the—it was really intended to be a way to provide public benefit through the deployment of solar, especially the early deployments of solar on the APS system. More recently, we have our Solar Partner Program that launched in 2014—late 2014, early 2015—that deployed about 10 megawatts. So, 1500 residential rooftops outfitted with advance inverters and the ozone experiment as well, with the leased rooftop space from the customers—so, an APS-owned system. It provides the customer a monthly payment.

And we wanted to test out how solar can be used to help effectuate voltage control and how it interacts with utility and grid-side voltage control assets, energy storage, and other technologies. And the APS Solar Innovation Study has outfitted 125 homes with solar in addition to a range of other behind-the-meter innovative technologies, things like smart thermostats, gridded active water heaters, load controllers, and central home energy management systems.

So, again, summarizing some of the projects—Solar Innovation Study, one of the big things we've learned with solar and solar deployments and managing solar on the grid is integrating energy storage as well to help with—to help really bolster the solar ability to ride through system peaks, better manage and better control voltage, because storage provides a resource that's available 24/7/365—whenever it's available, of course. I mentioned a little bit about the micro grids. There are two specific locations totaling about 35 megawatts.

I'll dig in next into the Solar Partner Program and the exact model and data around this. So, solar rooftop PV—we wanted residential deployments where the utility had specifications of the advance inverters. This predates the finalized versions of many of the communication control and operation standards for distributed generation. So, we really were able to inform quite a bit of the industry, ongoing industry work on communications, controls, effective methods and strategies for integrating rooftop solar and voltage control, et cetera, with utility voltage control infrastructure.

So, the residential systems, we wanted them to be west-facing because of the coincidence that a west-facing system has with our system peaks. Arizona is very hot; it's very dry. We peak fairy late in the afternoon. So, customers are provided with a 20-year contract at $30.00 a month as a build credit. So, there's no direct behind-the-meter offset to their energy usage and there's no reduction in usage or change in billing from the customer's perspective. So, this is truly just a credit to lease their—the customer's rooftop space, But we were outfitted with centralized communications and control and we had the ability to reprogram the inverter. So, the technical reports and study details are also available at the links provided in this presentation.

I'll gloss over some of the lessons learned, but really, they're in the areas of planning and operations, advanced inverters, the applicability limitations, and how we could inform the interconnection process going forward to make sure we were able to maximize the capabilities of the system, and also maximize the amount of distributed generation we were able to connect to our grid. And then, interoperability and control—and communications was a very nascent industry when this project was started. So, we've seen that grow and we've been part of the team helping define requirements around standards, protocols, et cetera.

All right. Some of the lessons learned. We see voltage variability and impacts of voltage variability. So, you see a clear day solar PV output—and this is for one of our larger scale utilities, scale solar plants—on a semi-cloudy day and on a highly variable day, right? The voltage variability that follows a highly variable day is seven times the variability that you'd see on a clear day.

On a distributed system, for example, one of the examples here—this is one of our highest penetrative feeders—we have about 4.5 megawatts of PV on a feeder with a 10 megawatt peak demand, with about 800 residential PV systems. We see that without control and infrastructure we see voltage rise above our allowed operating voltages that have to be managed. So, we have quite a bit of work there in learning how to use advanced inverters with

advanced additional control features like voltage regulators and more advanced capacitor controls to help manage the system.

Then, I talked about why we chose to go with west-facing systems over leasing rooftop space. Here are three adjacent homes. One has a west-facing roof, an east-facing roof, and a south-facing roof, and you can see the spread in production throughout the day. It has a—it is significantly affected by the direction or orientation of the PV systems. And in fact, our west-facing solar PV systems have a 60 to 70 per cent coincidence with our system demand peaks, whereas the average for all solar systems are about 25 or 30 per cent coincident with system peaks.

So, I'll conclude there. And any questions or concerns?

Katie Great. Thank you so much, Daniel. As we shift to our next presenter I would just like to remind the audience that they can submit a question at any time using the question pane. And now, I'd like to welcome Kerry Klemm from Xcel Energy. Kerry?

Kerry Hi. I'm Kerry Klemm, and at Xcel Energy I oversee the day-to-day program operations of our renewable choice program, and that includes a wide variety of renewable options for our customers. I'll focus in today primarily on those that offer choices to distributed customers and some of the volumes and differences we've seen among our states.

Xcel Energy serves about 3.6 million electricity customers across 8 states. Our primary service areas are in Minneapolis—or Minnesota, surrounding the Twin Cities metro area but branching out to a wide variety of communities across the state. And then, also in Colorado—it has a very significant customer base, although we do have substantial operations in the other states listed as well. We're a nationally recognized leader in wind energy, energy efficiency, carbon emission reductions, innovative technology, and storm restoration.

As a company, we focus our three strategic priorities on leading the clean energy transition, enhancing the customer experience, and keeping bills low. And sometimes it seems like those things might conflict with each other, but we try wherever we can to find creative ways to work through those conflicts and come up with great solutions for our customers and the environment.

Looking at overall leadership in the clean energy solution, Xcel Energy made a pretty bold announcement last November that we were aiming to achieve 80 per cent reduction in carbon emission by 2030, and then aspirationally we are targeting and looking for ways to reach zero carbon emissions by 2050. And we just released a report yesterday done in collaboration with the University of Colorado that has more information on those carbon reduction aspirations and how they align with the objectives of the Paris Climate Initiative as well as how we've been doing in carbon reduction. We had a three per cent carbon reduction last year as a company, which is pretty notable considering that the electric industry as a whole went up by two per cent.

So, that kind of encompasses what we're doing on the universal scale. And then, below that we have some customers who want to engage and want to do more, and for those customers we offer customer choice renewable programs, and that's really the work that my team focuses in on. We have a variety of options for customers, including incentivized and non-incentivized private solar options, community solar, and then green pricing programs for those customers who want kind of the easy button for getting renewable energy credits to count for their own sustainability goals.

Within the community solar bucket, where I'll focus today, there's two options. There's company-owned and third party-owned. And I'll go a little bit into both of the models as they both are distributed on our grid so that you can understand better a little bit some of the drivers and impact for that.

This slide is packed with information and it really tells a tale of three states with community solar. I'll just start and go across. Garden ownership in Minnesota, we have 169 sites and over 500 megawatts of active community solar. Of that, about 17 megawatts are utility-owned. And those are solar gardens that started out third party-owned, and then as a company we have been purchasing them as opportunities that make sense become available to us.

And then, in Colorado we have 52 sites and 60 active megawatts. These numbers are all at the end of 2018. And they are mostly third party-owned as well. However, we are developing some company-owned low-income solar gardens to serve the low income requirements in legislation, and we're excited about how that has potential to pan out in the long run.

And then, community solar in Wisconsin looks quite a bit different. It's a lot smaller. As of today we have one active site with two under development, and we have one megawatt. This is a completely different model in that it's designed to be unsubsidized by nonparticipating customers. So, we have people buying into the garden up front. They pay $1,600.00 per kilowatt, and then in return they get a fuel credit on their bill for choosing solar energy instead of the traditional energy mix. So, they are paid per kilowatt-hour for the life of the garden.

As far as subscribers go, most of our subscribers are residential in our community solar gardens. What's interesting is that's when you look at the number of subscribers. When you look at the capacity, you will see that very small amounts of it are residential in each state. So, in each states it's commercial or municipal—schools, governments—subscribers who are making up the bulk of the subscription.

Because the subscriptions are third party, the cost of the subscription is set by the garden, and those costs and escalators vary quite a bit by contract. So, we always advise customers to be very aware of the contracts that they're signing and what assumptions are used to make sure that they're comfortable with any risks that might exist because most of our bill credits do change by year. And as you look at the different bill credits by state, you can see why Minnesota has grown so rapidly to go from zero megawatts of community solar in 2015,

right around 1 megawatt in 2016, and at the end of 2018 we had 500 megawatts. So, that's pretty rapid growth driven primarily by this bill credit. That makes it very lucrative for third parties to come in, and there is no program cap, so that drives that as well.

We're currently in a market where new gardens get the value of solar, which is a little lower than the applicable retail rate bill credit, which also had a REC added to it. So, it just depends on what year the garden application was completed. That locks in their bill credit percentage for the life of the garden.

In Colorado the bill credit is retail minus transmission and distribution, which is a pretty—fairly common model from what I've seen across the country. And that leads us to about 5.2 to 7.3 cents per kilowatt-hour. And then, in Wisconsin it's a similar type of formula, and rate differentials lead to different values there.

Minnesota currently does not have a low income requirement for its community solar gardens, but we do see some developers starting to naturally navigate toward that. And so, there is some activity in the space. In Colorado there is a five per cent of capacity requirement initially, similar to Holy Cross, that was taken on by the solar developers who were developing the larger solar gardens. They would allocate five per cent of capacity to low income customers and then work with different community action agencies or other entities to subscribe that capacity.

Today, through some changes in the program, the company—Xcel Energy—is taking on a portion of that capacity through our company-owned low income solar gardens. And there's also an annual RFP bid for low income community solar of four megawatts per year.

So, this just gives a little more detail about the Minnesota community solar garden legislation. All community solar gardens in Minnesota must be distributed on the network and they must have at least five subscribers. No subscriber can have more than 40 per cent of the garden. They are limited to 1 megawatt in size, although we—initially, when we opened the program we had over 1500 applications come in in the first couple days, and a lot of those were co-located. So, what you would see is 30-, 1-, 30-, 50-, 10-, 15-, 1-megawatt gardens all bunched together in a single location, and they were co-located so that they looked more like a large scale solar farm. We worked with the developers and the PUC to come up with a compromised position whereby for a limited amount of time five-megawatt solar gardens could be co-located together. And co-location has some complex definitions in how it's defined in the statute and in tariffs, and so there remains locational disputes about whether things are co-located or not. And we have a process for alerting them when we see things that we're not sure of how to handle and then it's handled through a regulatory process.

So, we do have some very robust penetrations on some feeders. We've seen a lot of these solar gardens built out at the edge of our distribution system where loads are low but land is cheap. And so, as an agricultural state there is a lot of land out there, but we are starting to reach capacity limits at some of

our distribution feeders and substations. And so, that's been interesting to work with the developer community through that and create tools like early capacity screens to help the industry understand the situation as they're looking at negotiating land rates and permits to get an early, high level go/no-go on some of the projects. Not necessarily saying that there will be capacity once we go through the full power flow studies and protection studies, but more giving an early heads-up that "Hey, there's already a lot more solar here and in queue than the load and the transformer capacity might allow. So, that's been a useful tool for some developers.

We also host—or, have on our website hosting capacity maps that show kind of red, yellow, green areas. They're hard to keep current, because like many utilities our records are a little bit all over the place, but we do try to keep that updated annually or so, so that people can get a good feel for sites that are really not going to work well for them.

In the program the—as in all of our interconnection processes, the solar developer or the customer causing the cost pays for the upgrades. And so, we do have a million dollar cap for co-located projects above one megawatt that require distribution upgrades. So, we will do up to a million dollars of distribution upgrades for those projects, but after that they get a "no capacity available without additional upgrades." We've gone through a workgroup process to change how we study our power flow modeling and to change some of those voltage rise calculations that we do behind the scenes. I'm not in engineering, so you could quickly get me stuck in that conversation. But we landed in a spot that for the most part has been working well since we've restudied projects under the more aggressive conditions, and we're able to reduce some costs for projects and award some additional capacity in some locations.

As of 2016, any new applications are limited to one megawatt co-location, and so we don't—no longer have new projects coming in at the five-megawatt size, but we do have a number of them that are still going through the process. We do simultaneous queue studies, which is challenging, as you can imagine because you have projects that are—we study assuming everything ahead in queue is going forward, but that doesn't always happen. And so, a project can drop off and their cost can then transfer down the queue and we restudy. And that can lead to some uncertainty as projects are trying to get their financing wrapped up and get things nailed down. So, there's a lot going on and a lot of policy decisions that we try to make along the way to help support this level of distributed community solar.

Just looking really quickly at the business model and how it looks—the solar garden company contracts with subscribers who then pay for their subscription to the community solar garden. The community solar garden delivers the solar energy and renewable energy claims to Xcel Energy to be used on behalf of all of our customers. In return, all customers pay for the bill credit through our fuel clause and then that—the solar garden bill credit goes to the subscribers as payment for the energy produced.

Colorado is a little different. It was one of the nation's first larger-scale community solar garden program, and until Minnesota took over the program for largest program in late 2016 from Colorado, Colorado was the largest—our Colorado program was the largest program in the nation. We run RFPs for a limited amount of capacity each year, and that makes the program more market price-based versus a price that's set through legislation or rulemaking. So, the bill credit that the customer gets is a PUC-approved amount, and then the solar gardens bill for the REC price. And we have in the past had negative RECs, which basically is a function of the bill credit being high enough to support the solar garden and them able to bid negatively for the ability to participate in the program. So, it's led to some really competitive pricing for our customers in some of those instances.

So, this just looks at all the different types of community solar we have going in Colorado and the capacity that we have for 2019 in each area. And there are minimum capacities as well. So, it's a range.

And then, I talked a little bit earlier about Wisconsin and what community solar looks like there. So, that program is sold out. All of our capacity that we have available has been allocated. In the future we are shipping to a model that is called Renewable*Connect. It has similar benefits but it pays per kWh with long-term contract options. Renewable*Connect is a program that's not distributed in nature. Typically, they tend to be universal scale facilities, at least as we've rolled it out so far. In Minnesota we had a 75-megawatt option and in Colorado we had a 50-megawatt option, both of which have sold out, and we are considering the future path for the program in both of those states. Wisconsin is launching this in March and they will—we'll actually replace our premier green pricing program, which was called Windsource, with Renewable*Connect, which is a mix of wind and solar resources.

So, this is just a high level, some lessons learned. Expect things to take some time. I think everybody was a little surprised at how long it took from our 2013 legislation till the first garden started coming online at a pretty good clip at the end of 2016. There were a lot of things that needed to be worked out, both in terms of the process to take on that much distributed energy and the analysis behind that, and the field and design and construction crews to support it. It took a while to figure that all out.

And then, I think the other thing, just to be aware of, is that everybody has expectations and everybody is trying to do, I really think, the right thing for their business and their customers, and sometimes that can lead to conflicts and there are many issues to resolve. And at the same time, the expectations and—of the industry are very high because they have financing deadlines to meet and they have very complex business models that they're running behind the scenes in order to manage a portfolio of projects, whereas as a utility we tend to look at each project individually. So, that's been a lesson that we've had to learn.

There's a lot to balance. In general, I think having an engaged cross-functional team can lead to success because we have developer workgroups that we hold where we have those two-way conversations about what's not

working for them and we can go back and look at what can we do to resolve that for them or work together, or maybe there's some areas where we can't. But we really try to resolve issues as they occur.

And then, internally we also have a cross-functional team that meets once a week and has people from every area that's touched by this program and the distributed energy project to make sure that we're talking through issues as soon as we see them and trying to resolve them before they bubble up on a larger scale.

So, with that, this is just a handy list to come back to of the things that came top of mind of different issues to consider as you're looking at distributed generation programs and the impact they might have, both from a policy and operations standpoint. So, these are just some resources and I look forward to questions in a little bit.

Katie

Great. Thank you so much, Kerry, for that awesome presentation. Next we will welcome Chris Bilby to the webinar as our final presenter.

Christopher

Hello and good day. My name is Chris Bilby. I'm a research engineer at Holy Cross Energy. Holy Cross is a—or, Holy Cross was founded in 1939 and has grown to serve 43,000 members spread across 57,000 meters all on the western slopes of Colorado. HC is committed to a clean energy future with our "Seventy70Thirty" goal to supply at least 70 per cent renewable energy while reducing emissions by 70 per cent, and all of this at no additional cost to our power supply.

Here are a couple of graphs kind of showing how we're going to get there. The gray line is—it's what it would look like if we didn't do some of the stuff that we're trying to be progressive with, and the right graph kind of shows renewable energy percentage and where we're trying to get.

A couple of ways that we're going to try to get to our 70 per cent goal. It's a 100-megawatt wind farm that's schedule to go online in 2021, a 30-megawatt solar farm by 2022. We're additionally putting five megawatts every three years on our distribution system. We have two in permitting right now. And then, we're pushing for two megawatts a year of behind-the-meter rooftop solar.

In late 2016 and early 2017 the National Renewable Electric Cooperative Association, also known as NRECA, surveyed to identify the driving decisions to offer or support solar programs, including community solar, utility-owned solar, and rooftop solar. It found that 68 per cent were motivated by the desire to increase customer satisfaction, 59 per cent were motivated by customer demand for solar offerings, and 43 per cent were driven by the decline in solar development costs.

In a community solar model, the utility customer participates by contributing either upfront or ongoing payments to support solar projects. In exchange, the customer receives a payment or a credit on their electric bill that is proportional to either their contribution or how much electricity the solar

project produces. Usually, utility or some identifying third party owns the solar system itself. The participating customers have no ownership stake in the solar system; rather, the customer buys the right to the benefits of the energy produced by the system. The benefits of ownership are transferrable. If an owner moves within our service territory, the bill credit follows them. If they move outside the territory, an owner can resell to another ownership or they can pay back at fair market trade or donate to a nonprofit.

Early programs required a significant upfront investment. More recently, implemented programs offer simpler options such as a nonbinding monthly subscripting or even multiple participation options. Co-ops are integrating solar into their primary business model, offering members behind-the-meter-equivalent community projects. They are also enhancing economic development in response to the growing demand for green energy services in the cooperative sector by determining how best to supply services such as solar and energy storage to key account commercial and aggregation to customers.

Holy Cross was a pioneer in community solar. We have 100—we've been 100 per cent subscribed since our first system came online in 2010. The Clean Energy Collective, also known as CEC, and Holy Cross Energy provided a member-owned model that enables individuals to directly own panels in a community solar farm, combining an on-bill credit and utility-owned project with the equivalent tax benefit.

CEC took advantage of a 30 per cent income tax credit and adjusted the cost to the participants. Portions of the array were sold to members at a discounted cost. Then, using net-meter economics, the member receives a power production credit on their bill. CEC also sold the rights to all future RECs up front on a per-watt basis, enabling them to offset portions of the installation costs.

Moving solar into a low income community was a natural transition for Holy Cross and a great example of cooperative collaboration. We were able to combine to programs which already existed, community solar and low income, and construct an array without any additional cost to our membership. HCE worked with Great Alternatives Colorado for the installation and the Colorado Energy Office for financial assistance. We received nine matching grants for this project. The low income array benefits co-op members who spend more than four per cent of their income on their energy bill. We have 43 families receiving solar credits based on their 12-month prior usage. The enrollment period is for two years and their allocations are up to five kW bill credit, with a goal of offsetting 50 per cent of their electric bill. After two years, the lotto is reopened. One note that we had with success on this is we saw a dramatic improvement in the credit history of the participating members.

The graph on the left shows the escalation payments made by our community solar projects versus NREL's PV cost benchmarks. It is important to reconcile the incurred costs of community solar versus the declining costs of

installation. The graph on the right shows the progress of community solar among all co-ops, which is now up to 200 programs.

So, why is that? Well, in 2013 the Department of Energy selected NRECA to lead a solar utility network development program as part of the SunShot initiative. The mandate was to identify and eliminate barriers preventing electric co-ops from completing community solar development. Since then, standardization, scalability, financial solutions, and declining equipment costs have made solar generation projects more affordable. SUNDA aimed to accelerate the development of PV solar by converting the real world lessons of co-op solar developments into an array of tools and guides that can be used by co-ops across the country. Each of the 11 SUNDA partners planned a solar project of at approximately one megawatt, the size at which utility-scale projects become economically viable.

On the business side of the project it can be thought of in three parts: how to finance a project so the costs of implementation are equitable among shared members; how to provide and charge for solar energy for those co-op members interested in purchasing this option, and how to ensure a solar array can minimize the risk for the co-op.

It is often hard for co-ops to find investors for projects in the $1.5 million to $3 million range when many investors are funding deals in the $50 million range, so the co-ops worked together to develop a program called the Solar Cooperative Community Project to raise the deal value by combining multiple projects. They also worked with Co-Bank, a financial service for co-ops in developing an inverted lease, or lease buyback program, which was essentially a lease with a buyout clause, but it required the co-ops to have either a taxable subsidiary company or a taxable partner to make it work.

The prime purpose for us co-ops' existence is to provide at cost power to our members. Some members are rightfully concerned that spending millions of dollars installing solar arrays may not be—they may not be self-sustaining and thus increasing the rate paid by all members. Like HCE's community solar programs, most programs were offered to their members as a long-term lease on the energy output on X number of panels in return for a high upfront payment. But some co-ops, even though their members supported the project, the subscription rates were low. For best practices, community solar business models that require no upfront charges or long-term commitments enhance the member's interest in subscription.

As part of this project, the total of solar capacity owned and contracted by electrical co-ops has skyrocketed from 94 megawatts to almost 900 megawatts, a nine fold increase. Electrical co-ops now host nearly 65 per cent of all utility-sponsored community solar projects and have developed several programs designed to give low-to-moderate-income members access to solar power.

Co-ops' fuel mix is trending away from coal, but co-ops still own 26.6 gigawatts of coal capacity. There are now renewable energy mandates in 29 states as federal subsidiaries have driven the growth of renewable resources.

Economics of scale, falling panel prices, and new business models are dramatically reducing the cost of installation of solar for co-ops. Leading the way is 24/7 full-service energy trading where you can trade coal for wind and build utility-scale solar for under $30.00 per megawatt.

Government policies are another big reason for the expansion of solar energy. Solar and wind power grew due to the federal tax credits of 2012, then slowed when they were expected to be discontinued, and then picked back up when the credits were extended. The tax credits even affected the time of year that renewable projects were built. Most renewable projects are completed in the fourth quarter of the year, due partly to the timing of the qualification of the federal, state, and local tax incentives.

State governments also helped growth with renewables with laws setting targets for renewable energy uses known as *renewable portfolio standards*. Although the federal tax incentives are the primary factors for renewable projects, RPSs are another important driver. They've been adopted by 29 states, including Washington, D.C., and several others have adopted voluntary standards.

Community solar now. HCE is currently evaluating utility solar at 30 megawatts and wind at 100 megawatts to help achieve our renewable goals. The current market value for renewable energy credits, or RECs, from utility-scale projects is significantly less than historical community solar programs. The utility-scale development results in a reduction of costs to all members, including those who have already elected to procure 100 per cent renewables through existing programs. We see this program filling three buckets: (1) large reduction in costs for energy purchases from renewables, (2) RECs for our 70 per cent renewable commitment, and (3) RECs to help members in our community partners to help achieve their own renewable portfolio goals.

So, what does community DG look like in the future? Community energy storage is a hot topic, where communities and neighborhoods install a distributed energy storage system for demand control reduction, energy arbitrage, demand response, and resilience. Community generation coupled with transportation, where a member can subscribe to a DG farm that is integrated with the EG charger manufacturer for the sole purpose of providing renewable fuel for their transportation needs. Flexible capacity and controlling DERs are in the very near future and will help—with the help of organizations like NREL, HCE has been able to work on micro grid templates to support community models, increase DER controllability and resilience, giving us real-time feedback-based optimization of our distribution grid and large-scale DER coordination. All of these will be very important as we try to integrate distributed generation into our communities.

Thank you for your time.

Katie Great. Thank you so much for that, Chris. And thank you to each of our panelists for those outstanding presentations. As we shift to the question and

answer session I would just like to remind everyone that they can submit questions at any time using the question pane.

All right. Wonderful. So, we've had some great questions from the audience. And we will begin with—excuse me, I'm having a technical issue. Okay. Great. We'll begin with one of the questions from the audience, starting with Doug—and please feel free for any of the panel to please speak up on any of these questions as well: "What is the difference between community solar and purchasing renewable energy certificates that just happen to be from a solar project? And can you—how does that help a low-income household to reduce their energy costs if they have to pay to join?"

Doug

Sure. So, I'll answer the first question first and then go to the low-income customer piece second. So, the difference between the community solar and just purchasing RECs is that in the community solar model you could—and again, these are—these vary a lot so there's no one size fits all answer to this, but generally speaking the difference is that in the community solar model subscribers are actually purchasing a share of the community solar garden and they're entitled to a certain amount of the benefit of that community solar garden in terms of bill savings or revenues. So, they're almost like a member of the ownership of the asset, rather than, say, I was just a non-subscriber and I wanted to purchase renewable energy certificates for just their value. So, that's kind of the major difference, is that the RECs, you're only purchasing the value of the renewable energy certificate, whereas in the community solar you're actually investing funds in an upfront model or investing funds over time and expecting to see a return on that. So, there's actually a cost savings to the subscribers generally.

Now, with that said, for low-and-moderate-income carve-outs or any other creation of low-income community solar, generally the way that it works is the low-and-moderate-income subscribers do not pay an upfront subscription. They are given a certain subscription to the garden and they see the same bill credits—or they could see different—but they see a certain amount of bill credits each month. So, it's really just providing—the solar system is providing them a benefit. How that's generally tended to work so far is that that subscription is—you can say it's more or less paid for or subsidized by existing low-and-moderate-income grant programs. So, there's a lot of work looking at Weatherization Assistance Program, or WAP in the US, which provides a subsidy to low-and-moderate-income housing for energy efficiency and weatherization measures, taking at some of that money or looking at taking some of that money and using it to exist in a solar array. A portion of the WAP and also another program called LIHEAP, without getting too much into the detail, there's subsidies available to already annually subsidize low-and-moderate-income consumers' energy bills. That money is taken and invested in these community solar gardens to provide savings to those low-and-moderate households, income households over time.

Katie

All right. Great. Thank you, Doug. Would anyone else from the panel like to add to that?

Riccardo Hi, Katie. I just want to add a little bit to what Doug was saying in terms of the low-income or moderate-income customers and their participation in the community solar. In cases of developing countries this could present an opportunity for where energy is highly subsidized by the government and perhaps represents a big cost to the federal budget. It presents—it could present an opportunity for them to utilize some of these funds to move away from the energy subsidy that is perhaps paid on a monthly basis without an exit strategy. It provides them with a way of providing clean energy and a socialization or democratization of the clean energy to the population in general, especially the low-income population. So, it's just one example of an opportunity that in some countries may be looked at.

Katie Great. Thank you so much, Riccardo. Our next question is for Kerry. Kerry, an attendee would like to know: "For Xcel, where the community solar program is driven mainly by the government legislation, and what is the benefit to the utility, and how do the customers respond to the community solar programs and gardens?"

Kerry Wow, that's a big question. In Minnesota and Colorado legislation drove the creation of the community solar garden program and public utility commission proceedings further defined what those looked like. So, it was primarily driven by legislation and government initiative. In Wisconsin we proposed the initiative based on customer needs, and we wanted to try a different model and see if we could make it work. And we did. It was successful. It sold out. It's non-subsidized by non-participating customers and there was enough interest to fill up the program. However, we found that there was also a lot of interest in Windsource, which was our green pricing program where people pay slight premiums to receive the RECs from wind facilities and then get a fuel credit for using wind instead of a traditional energy mix. And that model has carried through with Renewable*Connect where it's a mix of wind and solar.

As far as how customers have responded, I'll start with Minnesota where the bill credits are pretty rich, and that's enabled subscription costs, at least initially, to be lower than the bill credits, so the customer is saving money day one. Customers who subscribe to it are primarily pretty happy with that. There's some confusion because there's been a lot of players knocking on doors and going—contacting different customers, some customers more than once, causing some market confusion that we can't directly address because we're not the ones doing the marketing. So, that can get confusing once in a while. But for the most part customers who are signing up, especially school districts, communities looking to save millions of dollars over the life of their subscription, are pretty excited.

But then, there's also some risks to that because those projections are based on bill increases from the utility, and some of those projections, even in the advertising that we've seen, go four to five per cent per year, and our costs have actually been going down year-to-year, so there's been some pretty tough conversations with our community solar work groups where we meet with the developers talking about how renewables lead to lower costs in the

long run because fuel costs are declining, and what that might look like. There's a wider range than maybe what we've seen in the past in terms of rate increases. So, there's some risk there. Customers respond differently to that level of risk, primarily depending on how well they understand it.

And then, in communities we do get sometimes some feedback from non-participating customers, both about the cost of the program that everyone is bearing, and then also the impact to communities that are primarily rural. And some communities embrace this wholeheartedly and others are more apprehensive about the changes that it brings to their communities when there's large amounts of solar being built on the distribution system. Hopefully, that answers it all.

Katie Got it. Yes, that was a lot to unpack. Thank you so much, Kerry. Our next question is for Daniel, and this might also be relevant to Kerry and Chris as well, if you would also answer. "What are some of the challenges you foresee integrating high penetrations of renewables into the APS grid?" Daniel, do you want to start?

Daniel Sure. So, some of the challenges we see, I think it depends from our perspective on what the drivers are and what the impacts to the system are. So, we on the APS system have a significant amount of solar as a resource. So do our neighbors in California. And we're one large interconnected grid, right? So, some of the near-term forecasts, we're showing that we—as a region we're going to start running into issues where we're encroaching on minimum load of some of the conventional generation resources that have to be online in the late evenings to serve peak or in the nighttime when solar resource is not available, which sets up a conflict in how the resources can participate on the grid.

So, APS over the last—I think two years ago joined the California ISO Energy Imbalance Market where we could—it's essentially a larger balancing area footprint for the California—so, where instead of curtailing their renewables they could have Arizona and the other EIM participants back down their generation and absorb more of that—more of the California-generated solar when you have, when you run into overproduction. Right? So, we're setting the industry up for a mismatch between production and demand with relatively inflexible resources.

What APS is doing to try and help manage that change and help us increase our capacity to keep adding more renewables is looking at energy storage deployments and expanding programs like demand response and customer-responsive type of technologies even down the residential level so that we can better take advantage of the resources, especially solar resources while they're producing in the middle of the day and help reduce those peaks late at night. And any energy we can offset from the nighttime to the daytime would be of some advantage. That's it.

Katie Great. Thank you. Thank you, Daniel. Chris or Kerry, would you like to add any challenges you foresee?

Chris Yeah. Holy Cross is in a lot of the same—having a lot of the same problems as Arizona there and Xcel. We have one feeder right now that's completely shut down and can't take any more distributed generation on it, and we're working with Xcel actually on upgrades to the substation on how we can provide more resources out there. Because of our geography and our terrain there's only pockets of areas where you can build one-to-five-megawatt arrays, so a lot of the larger arrays are being built in the more rural areas where the farmland's a lot cheaper, a lot like Xcel was saying. So, we are seeing problems. We do have feeders shut down and we're working on solutions.

Katie Great. Thank you.

Kerry And this is Kerry, and I touched on quite a few of these during my conversation. But I think there's everything from voltage fluctuation and capacity limits, transmission backfeeding—how much can you backfeed onto the transmission system before it starts to raise concerns, especially as the solar is built at the fringes of the system and far away from customer loads?

Also, there's community impacts to consider. We get e-mails pretty regularly from people asking, "How much more can we expect?" And we can't really answer that question because it depends on where the third parties decide to locate facilities.

And then, there's also ongoing concerns about non-agricultural use of prime agricultural land and some of the aesthetics associated with that as well.

Katie Great. Thank you to everyone for addressing that. Our next question is for Chris. Chris, how will peer-to-peer energy trading affect the model for utility-owned DG?

Chris Yeah, well, that's something we're looking at on our micro grid template. It could completely kill utility-owned DG, especially PV, if the rates come down and if members can figure out how to make additional money off their generation, or storing and selling it during peak, especially if we go to a strong time-of-use program. So, I do think it will have a dramatic effect on utility-owned and the strategies behind it.

Katie Wonderful. Thank you so much, Chris. Our next question comes—we have a lot of attendees that are outside of the United States, and so this is more of an international-based question. "What is the advice from the panel—or what have they found about the utility communicating with the regulator to get the program started?"

Chris Holy Cross is—we're a little bit different than everybody else. We're unregulated. We're not regulated by the PUC, so it doesn't really affect our strategy.

Kerry This is Kerry. I think that we compiled programs to align with the legislations for community solar and then went back and forth through a lot of comment period and stakeholder workgroups, entitlements, to come up with a final

program design. And I think approaching it with an open mind and understanding kind of the mindset of your regulators would be helpful going into it so that you're able to find compromises wherever you can. And then, where you can't find compromises with the industry or with other parties, environmental groups, et cetera, just go in and look at the PUC as kind of the final decision-maker there. That seems to have worked pretty well for us.

Daniel This is APS. I agree with Kerry's comments. And I think one of the things that—or some of the things we've experienced that we learned lessons from and we're working on things to improve are regulators are in a tough spot because they've each got maybe their personal position but they also have stakeholder constituency groups to deal with. Like, in Arizona our utility regulators are elected body—right?—so, it's a body of five elected officials. And so, they've got stakeholders and community advocates and the residential consumer advocates, limited income advocates. So, they have a lot of differing perspectives that they have to try and find some middle ground on, and sometimes we see, well, there's desire for moving in one particular direction, but we try and bring facts, figures, data, and also the perspectives of other customers because ultimately if you want to get to 100 per cent renewable like some of the other entities you've heard on the call here, that's noble intent, but 100 per cent, does that get you to zero per cent or zero carbon or truly decarbonized? What does it mean with your existing energy mix? What does it cost ultimately? Right? And who ends up paying that cost?

So, we've been a lot more engaged with advocacy groups and stakeholders who would be talking through things with commissioners as well outside of the commission type of interface so that we understand what those perspectives are, we understand where our customers are moving, we understand where the markets and the technologies are moving so that we can make really well-informed plans going forward and then also being flexible to accommodate needs of multiple stakeholders. But it can be a challenge because some of them are—many of them are very often in direct conflict.

Katie Thank you so much, everyone. I think I have time to squeeze in one more question, and we'll start with Doug but this is also relevant to Kerry. Doug, do you have any advice on where is the best site community solar projects to maximize their benefit to the grid?

Doug Sure. So, the—yeah, I'll let Kerry talk more on the technical in terms of where it makes sense from a transmission or distribution side. But from a development side one of the advantages of community solar is that you don't have to—you still have to find ground mount space but that can be somewhat flexible in that you don't have to necessarily deliver those electrons to all the subscribers. So, areas that I have seen that have worked well have been areas that were brown fields, whether that be on top of landfills, near landfills. Near substations is always helpful for interconnection. Slope is a really big one, making sure that the ground area is under maybe three to five per cent slope, although PV arrays, if the economics work out, you can go to higher than that potentially. Yeah, so I mean, those are some of the—and then, the environmental considerations of is this, has this land been disturbed and are

there wetlands and are there endangered species that could be affected? Airports are another big one that you want to not get too close too to avoid additional review. Those are just some of the development considerations that you might think about. These are generally handled by—if it's a third party community solar developer, that's their job, is to look at that sort of thing. If it's the utility side, possibly doing some research around or talking to developers about what type of development concerns they should be aware of. It's super important to avoid investing development dollars in projects that—or sites that won't be ultimately developable.

Katie Thank you so much. Kerry, do you have anything to add to that?

Kerry No, I think it's something we're continuing to look at and try to resolve and figure out how to drive more community solar and distributed solar closer to the load, but doing it in a way that makes sense with all of the other factors that have been presented. So, it's complicated and we're still working through it.

Katie Wonderful. Great. Thank you again. On behalf of the Clean Energy Solutions Center I'd like to extend a thank you to our wonderful panel that was gathered today and of course to all of our attendees for participating in today's webinar. We very much appreciate your time and hope in return that there were some valuable insights you can take back to your ministries, departments, or organizations. We also invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including the no-cost policy support through our Ask an Expert service. I invite you to check the Solutions Center website if you'd like to view the slides and listen to today's presentation as well as other previously held webinars. Additionally, you'll find information on upcoming webinars and other training events.

We're now posting the webinar recordings to the Clean Energy Solutions Center, so please allow about one week or so for the webinar recording. And please also look out for the next webinar in the DG campaign series, which should happen later this spring.

Finally, I'd kindly ask you to take a moment to complete the 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 and the next DG campaign webinar. This concludes our webinar.