Interconnection of Distributed Generation (DG): Technical and Regulatory Aspects

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Webinar Panelists

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Katie (Moderator) Today's webinar is focused on interconnection of distributed generation: technical and regulatory aspects.

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 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 you're having any technical difficulties, you can use the help—Got Webinar's help desk with the far, excuse me, with the number on the screen.

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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's resource library as one of many best practice resources reviewed and selected by technical experts.

Today's webinar will address DG interconnection processes and discuss approaches for mitigating impacts of distributed generation—distributed energy resources, excuse me, DERs. Before we jump into the presentations I'll provide a quick overview of the Clean Energy Solutions Center. Then, following the presentation we'll have a question and answer session where the panel will address questions submitted by the audience. At the end of the webinar you'll 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. Twenty-four countries in the European Commission are members contributing to 90 per cent of the clean energy investment and responsible for 75 per cent of 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 and policymakers design and adopt policies and programs to support the deployment of clean energy technologies. This is accomplished through 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, included—including a team of over 60 global experts that can provide remote and in-person technical assistance to governments and government-supported institutions, no-cost virtual webinar trainings on a variety of clean energy topics, 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 private sectors, NGOs, and civil society.

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

Today's webinar, we have a wonderful panel and I'd like to briefly introduce all of our panel today. To introduce an overview of the topic we have Julieta Giraldez, who is a Senior Research Engineer in the Power System Engineer Center at the National Renewable Energy Laboratory, or NREL, where she currently leads microgrid and smart grid and grid integration-related projects. In recent years Julieta's focus has been on integrating emerging technologies such as PV, energy storage, microgrids, and distributed systems.

Following Julieta we will hear from Ignacio Romero, who is a Director of Distributed Generation at the Undersecretariat of Renewable Energy and Energy Efficiency of Argentina. He oversees the development and implementation of the distributed generation program at the national level, participating from the formulation of law 27.424 up to its associated regulation and implementation.

After Ignacio we will hear from David Parsons, who is the Chief of Policy and Research at Hawaii Public Utilities. David is responsible for policy analysis and strategic planning for achievement of the state's aggressive clean energy goals. He oversees the commission's proceeding son renewable energy procurement, distributed energy resource integration, demand response, long-term system planning, grid modernization, and utility business model transformation.

And our final speaker today is David Brown, who is a Principal Distribution System Engineer at Sacramento Municipal Utility District, which is also referred to as SMUD. His 35-year career has included distributions—excuse me—system capacity planning, overcurrent protection design, dispersed generation interconnection, reliability planning, Distribution automation project management, and technical support on a variety of R&D projects.

And with those very brief introductions I'd like to welcome Julieta to the webinar to introduce our topic. Julieta?

Julieta: Thank you. And thank you for having us. I'm going to introduce first the distributed generation campaign and then I'll introduce the topics. So, let me share my screen… and let's see, we can see it in… there we go.

So, before I introduce the topic today I wanted to talk about the 21st Century Power Partnership, which is one of the initiatives of the Clean Energy Ministerial that Katie introduced, and it aims at accelerating the global transformation of power systems. And so, the Power Partnership is a multilateral effort of the Clean Energy Ministerial, and it serves as a platform for public-private collaboration to advance integrated policy, regulatory, financial, and technical solutions for large-scale deployment of renewable energy, in combination with deep energy efficiency and smart grid solutions.

So, in May 2018 at the Clean Energy Ministerial 9 in Copenhagen conference Mexico launched a campaign with the 21st Century Power Partnership, and this is what we call the DG campaign, officially called the Campaign for Accelerating the Adaption of Distributed Generation is Specific Regions. And it's a 12-month campaign that was supported by Germany, Denmark, Chile, Brazil, and India. And NREL, the National Renewable Energy Lab, is the operating agent for the 21st Century Power Partnership initiative and the DG campaign.

And so, this DG campaign has focused in Latin America specifically and has had the following activities: a needs assessment for the Latin American region, a technical policy and regulation study tour, with representatives from 11 countries traveling to the US. I was lucky enough to be able to be part of that study, and we visited Colorado, Arizona, and California. And I always joke that next time we'll have to go see Dave Parsons in Hawaii, hopefully. [Laughs] But we didn't get that pulled through.

Other things: participation in regional forums in Uruguay, Brazil, and Chile. Two webinars—so, the one we had before on utility-owned PV systems or DG—distributed generation—systems, and this one on interconnections. And finally, a thought leadership report that will be released at the Clean Energy Ministerial 10, which is happening in Vancouver at the end of this month.

So, with that I'm going to introduce the topic of today, which is really DER system interconnection topics, and I borrowed some slides of my colleague, Mike Coddington, that has also been involved in supporting the DG campaign. And so, to introduce the topic, I think the first slide is a really good illustrative example of the topic because it really involves a lot of pieces, and so I think the puzzle image is very well done here. So, it includes rules, procedures, agreements that typically come in cooperation with federal, state public utility commissions—so, regulatory bodies and utilities—and then the market themselves—so, DG developers and customers. And so, it really involves quite a bit of stakeholder engagement. It's not just the technical part or the managing the applications part; it's also quite a bit of stakeholder engagement to make sure that everybody is onboard, that the rules and application and processes are transparent. And that is really what I believe that I've seen that makes an efficient and successful DER interconnection process.

So, one of the key things of the puzzle that are—it's very important that NREL has been focusing on, is providing support to the DG campaign, and also in general in the work we do in the US, is codes and standards—so, I'll talk a little bit about that—which is really what makes it that everything can work together in a coordinated and safe manner.

So, I'm going to introduce the concept of the interconnection process, the utility interconnection process. I wanted to note that typically if you interconnect a DER there are two parallel processes that will happen, one that is not shown in the slide, which is permitting and inspection approval process, which that happens with a local jurisdiction or authority where you can interconnect your DER. And then, the second approval process that happens in parallel is the utility interconnection process, and it's what we're going to focus on today. They're both happening in parallel and they're both very important and they both need to be completed to obtain the final permit to operate. But here you can see some of the things—this is, this particular image is taken from one of the federal interconnection processes defined in the US, which was actually defined after a lot of the states had done their own processes, but I think it's a good example of some of the steps that go into the utility interconnection process.

So, you typically start with an application, and then typically utilities in the US and all over the world, they're trying to define some type of fast track screen that makes it easier to go to the approval box shown there below, or if you fail the fast track screen, then you move into a supplemental review screen. And if you fail those, then you have to move into the more expensive, time-consuming impact studies and field verification data for approval or a recommendation of a mitigation study.

So, I think one of the things that is very important to think in general with DER interconnection is how to improve the fast track screens and make them specific to the conditions that the distribution utility company is being and try to learn from that to also inform the supplemental review screen. And I think that's one of the key things that we've been all working on to improve, and it's to develop more specific supplemental and fast track screens that actually give less false positives that then have to go into impact studies and more expensive—and make it easier for and remove barriers for interconnection.

So, some types of fast screens are based on system size, as shown below, and some other ones that you'll hear—I think I have—yes, this next slide, I think these are the ten ones included in the SGIP process defined here in the US. And they are not perfect. As you can see, the 15 per cent capacity penetration metric is still there, and we know it's conservative. And so, I think this is one of the key things that utilities across the world have to think of, and it's looking at their own experience and what specific rules they can define for the interconnection process.

So, just common utility concerns that we've heard here in the US and across the world, really, is—the main one is voltage regulation. So, that is when the DERs inject power into the grid, and especially if the load is not high during the day, it can cause a high voltage, and that is a concern. Protection coordination is another one, but that one is—has been, I think, easily solved. So, you may have to adapt the protection scheme. And then, some other ones are listed there, but a common one is also simply thermal overloads. So, when there's enough PV penetration you start really overloading the lines and the transformers.

I have here some common mitigation tools and strategies. I won't go through them. I did want to mention this new report that was recently published, and I think it's excellent—it's NREL and its partners here of the US—of an overview of interconnection, best practices for interconnection. And it really does a good summary, and it covers both the technical side that I was mentioning—so, the technical screens, but also best practices for interconnection application, procedures, and management—so, how to manage, really, the large amounts of applications. It covers advanced inverters, standards, and also strategies and upgrades for distribution system impacts, as well as a very interesting topic, which is cost allocation of the necessary upgrades. So, I think for all of them, the countries developing these policies, I think it's a very interesting report that I recommend you all to read for getting ideas and the lessons learned in this topic.

How am I doing on time, Kati?

Katie Oh, you're doing wonderfully.

Julieta Good. So, the last thing, I think one of the important things that we've been working on is smart inverters, as one of the mitigation strategies in the toolbox for integrating DER. And so, it's really that the inverter, which is the main equipment that transforms—right?—the power from DC, from the solar panels, to AC as a condition for the grid, that equipment can provide actually grid-friendly functions. And so, it can help support some of the impacts that the DERs cause. And so, we highly recommend that countries that are developing their interconnection policies and rules to think about DERs. And I think we'll hear a lot more from our panelists in the US on this topic.

And so, one of the major achievements here in the US last year was the revision of IEEE 1547. So, we reviewed the version, the 2003 version, that the philosophy of the 2003 version was to have DERs interconnect and only inject power but not to do anything with regulating voltage and frequency, and disconnecting as soon as there's an abnormal condition like a fault on the grid. And so, the big philosophy change with the revision of 2018 is that the more—so, these resources can actually provide grid-friendly function and stay online when there's a fault. And the more of these resources that are on the grid, the more important it is to do this. Right? And so, the classic example is the right capability. Imagine Hawaii and other distributed energy resources—so, PV is, residential PV, if you aggregate it, is their single largest generators. And so, if there is an abnormal condition and you lose all of the rooftop PVs, you are suddenly making the condition worse instead of maybe staying online until the condition is clear, and making the grid more stable throughout. So, those things are, I think, important and especially, of course, in island systems that see this impact first.

Final observations. I think what we've learned, at least in the US, is that distribution systems in general can absorb quite a bit of DERs and—before really getting into these high penetration PV challenges. So, yes, in general the grid and PV in the distribution system is robust enough to integrate large amounts of PV. As said, smart inverters can help increase the hosting capacity. And typically, the way they're being implemented right now is still with no communication required to these resources, and so the DERs or the PV systems provide this function locally based on their local measurements of, for example, voltage and frequency. And then in the future we'll see probably more and more advancements in grid modernization and the distribution system, and probably communication and central control schemes with such DERs.

And I think with that I'm going to pass it on to Ignacio Romero, that's going to talk about his experience directing the distributed generation in Argentina.

Katie Wonderful. Thank you, Julieta. And as Ignacio sets up his screen to present and we pass the mic to him I just want to remind our attendees that they can ask a question at any time using the questions pane. And now, with that, I would like to welcome Ignacio Romero to the webinar. He is the Director of Distributed Generation for the Undersecretariat of Renewable Energy and Energy Efficiency of Argentina. Ignacio, welcome, and thank you for joining us today.

Ignacio Hello, thank you for inviting me. It's a pleasure being able to share some of what we're doing here in Argentina. Give me one second, please. I'm trying to set up the file.

Katie It's wonderful. We can see your screen, so I think you're all set.

Ignacio Okay. Here we go. Okay. I will try to give a brief, or as brief as possible overview of what has been happening in Argentina in the last three years with the distributed generation law as a context to the discussion on the interconnection procedures and standards, which is, I think, as Julieta mentioned, key in enabling an accelerated implementation of distributed generation or distributed generation—I'm sorry, energy resources.

So, as I said, first, as a context, we now have since the end of 2017 a national law in Argentina a national law enabling distributed generation. Basically, we have decided on going forward on a net billing scheme. This is a scheme in which the excess energy is rewarded to the distributed generator at the wholesale price, and we'll talk a little bit more about why we chose that. Some other important characteristics of the law is that it establishes that the user will have at least—he has the right to request or to connect at least up to his contracted capacity for the month. So, this is really important—so, we can set a line in the system sizes and make the discussion between utilities and users easier. Of course, there is also some promotional incentives. There's a pretty comprehensive toolbox with the incentives that we have used to see elsewhere—financing, different relay type incentives, also tax credit certificates that could be used to foster the start of the implementation of the law. So, the main objectives, of course, we're all aware of what they are. We all know the battle that we are giving to climate change, and I'm not going to go a lot further in that direction.

Promotional incentives, as I said, basically financing options, tax credit certificates. Something that's also important and actually has to do with the implementation is that we exacted national tax exemptions for excess energy. Basically, something we—most people at least don't realize is that when you are a DG user and you're trading energy with the system you are not only buying, but you are also selling. So, a lot of taxes related to the sale of goods apply, such as income tax and value added tax. In this case, we have included an exemption in the law to this injection, to this activity. So, it makes it a lot easier. It is not only a promotional incentive but it also makes it a lot easier administratively, because if not, the tax authority would have to be—would require every single user, which could be households, to register this activity, this economic activity of generating and selling energy, and that's a lot of—there's a lot of bureaucracy involved that is not justified at all for a small to medium system.

Also, we have a set of supply-side incentives. We are trying to look for the most ways in which we can develop local industry related to distributed generation. So, we all know the services associated with these activities are really—really have a really big potential. We are also looking into different countries that are developing inverters or structures, some also solar panels—not as much as the other two, but we have—in the law we have certain mechanisms that will make them, make it easier for them to acquire some machinery and start their investments.

So, now going onto the regulatory part, one of the key aspects of the law is ______. Basically, we—the original project or the original draft for this law was net metering plus feed-in tariff, which is, which are two mechanisms which have been used and are widely used today all over the world. Now we analyze the different, let's say, problems or shortcomings more to say on these mechanisms and decided to go with net billing. Basically, we saw that feed-in tariff was a really, really good mechanism at first to incentivize the early adopters with a huge subsidy and had no relationship or almost no—yeah, no relationship with the market signals as of price of energy. Net metering was a great step forward in that sense, as it requires less subsidy from the government, let's say from taxpayers. But there are some questions as to the cross-subsidization between rate payers. And in Argentina, we are coming from a situation in which we had heavily subsidized electricity tariffs, up to 90 per cent subsidy in some cases, so it was really hard to push for a law that already included more distortions or was perceived as including more distortions into the mix.

The net billing scheme basically, as we said, all energy that the user demands from the grid is paid at the actual regulated tariff that applies. All excess energy is rewarded at wholesale price, which is basically the avoided cost, to the utility. So, there—in Argentina, in the case of Argentina, we are paying the cost of, average cost of generation of the wholesale market plus the average cost of transport, which is exactly the price the utility pays when they purchase the energy. So, for the utility, it's almost—it has almost no impact to purchase this energy from the distributed generator or, business as usual, from the market.

Something that's really interesting about the net billing mechanisms is that it provides a healthy price signal. So, we have demand, the excess energy is rewarded at less—at a lower price than demand avoidance, let's say. So, if you could use your energy, you're saving more instead of just injecting, so you avoid incentivizing, over-dimensioning of the systems, and over-generation, which is something that will complicate the discussion non the grid requirements for the systems. And also, it provides the correct signal, price signal for storage and for energy efficiency in the near future when these become, when storage principally becomes cost-effective or accessible widely.

So, basically, we're going to net billing. Something that's interesting too is that when we avoid most of the gross subsidies with net billing, the incentives are a lot more transparent. So, the end user, the beneficiary knows where the subsidy is coming from and doesn't assume things that are not correct.

So, now moving on to the regulatory update. So, after the law—I'm just going to go through the main points because I want to take some more time on the authorization process and the key parts. So, basically, we set a target of 1,000 megawatts of capacity by 2030. We also defined user categories based on capacity. We'll talk a bit more about that, but we defined the fast track for small- and medium-sized systems, and also we defined a maximum system size of two megawatts for distributed generation. Everything above—anything above two megawatts would have to go the wholesale market. And there's already a lot of regulation available for those generators.

We also enacted the web platform for implementation of authorizations and we're moving forward on the creation of the implementation of the incentives, as well as setting up the safety standards and technical requirements.

So, just going forward in more detail—and I think this is where we can talk more about the interconnection requirement—basically, at this point we already have a full online authorization process implemented. We implemented these procedures nationwide, so basically any user with a national ID can log in and request authorization to become distributed generation. This is really important because it allows us to be very transparent about this process. So, this platform makes—provides the medium of interaction between the utility, the user, and also the installer so the regulator can oversee everything that's going on and not only the cases in which there is a problem.

But basically, something that is really important is that as we defined all of the system-side requirements and the grid-side requirements for these approvals, we are using web forms. It's a lot easier to make sure that the user knows all the information that needs to be provided and provides that information. Also, that the utility knows all the information that is required and to make the evaluation and can work on that. So, I think it's not only the transparency but also the formalization and standardization of the process to make it easier for them to evaluate and not have to sign off on something that they're not sure if it complies or not.

Something that's also important, of course, is that with this full online authorization process we also have traceability for all these tax exemptions, and also we'll have a record—we have a registry of distributed generation users in Argentina, which will be used for future national dispatch planning when this grows up and becomes relevant.

So, moving on to what's required from the grid side and system side, I'll start with system side, which is the easiest. So, system-side requirements, basically there is a lot of information available and we use the standard industry best practices. There is something that we allowed on the regulation, which is basically our way of setting up these standards, is that we set up minimum requirements, minimum safety and protection requirements, but local authorities could request something else—I mean, not different, just incremental. The reason for this is that there is a lot of—there is not a really good understanding of the impact of these technologies. And we know the impact is not really detrimental to the grid, but not a lot of people or not a lot of the regulators have actually experienced—or, the utilities have actually experienced dealing with these systems on their grid. So, we wanted to make sure that they had the peace of mind in knowing that they could request something else. But we already know they'll find that unnecessary. Also, we set up qualified installer requirements, which is basically the person assumes all the liability on the protections and on the safety of the system, and we made that clear in the law. For component safety requirements we used the IEC or local standards, which are used widely.

Then, moving to the grid-side requirements, as I said, we set up three different categories of distributed generation users. Basically, as I mentioned at the beginning, we have an upper limit, which is the capacity contract that they have for demand. But also, we set up three different categories depending on their system size. So, we have small, medium, and large DG users: up to 3 kilowatts; up to 3, from 3 kilowatts from 300 kilowatts; and then from 300 kilowatts to 2 megawatts. What this allows us to do is—especially or specifically in the case of solar PV—is to go into a lot more simplification in the system, because there's a lot of problems that are general, or problems or concerns that are general to distributed generation technologies but are already solved and actually being improved, as was mentioned earlier with smart inverters and different technologies for solar PV. So, there's a lot of problems that are non-existent for solar PV because the technology has advanced enough or because there's enough experience on different countries or regions with different penetration levels, and we already know that's not a problem.

So, basically, we focus on solar PV for simplification of the process even further. We set up automatic approval thresholds. Basically, what this means is that if you require authorization to install a system of up to 3 kilowatts, typically a residential user or small residential user, your request—of course, provided you comply with all the system safety and quality requirements—will be approved automatically until 20 per cent of the secondary circuit capacity is met. So, after that, the utility will be allowed to go into the studies and check what the impact is, but we know for certain that with 20 per cent of this size system on a secondary circuit we won't have any problems. The same for the case of the medium systems. We put a more conservative figure of ten per cent. And then, from 300 kW to 2 megawatts, there's no automatic authorization procedure.

So, I guess the point in these fast tracks is that there is a lot of things that we know that are not going to happen—sorry—but we need to really be able to prove that that won't be a problem at all. So, we analyze demand curves and the systems. As you can probably imagine, a 20 per cent reduction in demand at midday will not be critical, especially if it is optimized to any grid operator or any grid. And also, we can discuss a bit more on the question phase. But also, on the protection side there's a lot of these issues that are non-existent or that are very easy to work around.

So, as very briefly next steps and current status, basically we have, as I said, the online platform is operational, and the different jurisdictions are adhering and implementing. We already have five major utilities online, which represent 45 per cent of the 6 million electricity users that we have in Argentina. And we're working on the other renewable energy technologies—micro hydro, wind, low power wind generators, et cetera—to include those. Of course, it probably won't be as simplified probably as solar PV and we'll be implementing all the promotion and financing and tax credit certificates for pushing forward these implementations.

We are also issuing a lot of documentation that I can comment on later because I think my time is up. But we are also drafting and issuing a lot of reference information for all the different stakeholders, and stakeholder engagement is really critical to the success of this implementation, so we're working a lot with the different parties to make it easier for them to adjust and implement this new regulation.

With that, thank you very much. I will pass the mic to the next person.

Katie

Wonderful. Thank you so much, Ignacio, for your presentation. We are now going to pass the microphone over to Dave Parsons. Dave is the Chief of Policy and Research for Hawaii Public Utilities Commission. So, Dave, welcome to the webinar.

David P.

Great. Thanks very much. I think… let me see if I…

Okay. Good afternoon and thank you very much for the opportunity to be here. My name is Dave Parsons. I'm Chief of Policy and Research with the Hawaii Public Utilities Commission. I'm very excited to be with all of you this afternoon and to share some of what the PUC is working on to help achieve Hawaii's clean energy goals. And in my presentation this afternoon I'll discuss a bit about Hawaii's historical and future projected renewables growth as well as distributed energy resources, integration, challenges, and several critical policy developments we are undertaking here to facilitate the transition of the electricity system. And just a quick disclaimer: My comments and opinions are my own and may not necessarily reflect the views or policies of the commissioners.

So, just a bit of background: Hawaii has some very aggressive clean energy policies, including 100 per cent renewable portfolio standard by 2045, and a 4,300 gigawatt-hour energy efficiency portfolio standard by 2030. Each of the islands is moving rapidly towards these overarching policy objectives. And just to provide a little bit of background or context, Hawaii has six main islands served by electric utilities, and each of these islands is electrically independent, and the electricity demand on the islands varies quite a bit. Our smallest islands in terms of electricity demand have peak loads on the order of 5 megawatts, and our largest island, Oahu, where the city of Honolulu is, where I am, has a peak load of a little over 1200 megawatts. And at the end of 2017 Hawaii had achieved about a 28 per cent overall for the state towards their renewable portfolio standard of 100 per cent, and more than 2000 gigawatt-hours of first-year energy savings towards the energy efficiency standard.

And so, this is remarkable progress. But we still have a long way to go. And it seems like every time we hit some new milestone there are new challenges that seem to arrive on the horizon that we continually have to evaluate and address.

So, to provide a little more detail on the types of renewable energy resources that we have here in Hawaii—these charts are for the Hawaiian electric companies which serve about—five of the six main islands, about 95 per cent of the population. And as you can see, they're increasing their percentage of sales that are coming from renewable energy, and this has been predominantly fueled by the growth in distributed resources, particularly rooftop solar PV. And I think this is in contrast to other places in the United States on the mainland which have seen growth in utility-scale solar PV, but in Hawaii, like I said, the solar PV has historically been on the distributed side.

So, across the state between about 15 per cent and about 20—or 20 per cent, depending on the island of all residential customers now have PV systems on their—serving their needs or some portion of their needs. And it's higher if you're just looking if single family homes: It's about 30 per cent of all single family homes in the HECO company-serviced territories have PV.

And looking forward into 2020 and out to 2030, we're expecting continued growth in distributed PV, and we think that that will be bolstered with increases on the utility scale side as well as larger projects that start to be solicited in competitive procurements.

And so, on the sixth island, the island of Kauai, this is an island served by a cooperative utility. Customers there have benefited from early adoption of utility-scale PV and storage, and so that's significantly boosted the RPS or renewable portfolio standard achievement there. And in contrast to some of the other islands here, Kauai does not utilize wind or geothermal resources and—but they do have a relatively diverse portfolio of renewables, and we think that'll be the case in the future. Kauai is expecting to continue to add more PV and storage products, as well as potentially pumped hydro. And they are forecasting to achieve potentially as much as 70 per cent renewable as early as next year and continue on from there.

And I think the dramatic cost declines in the technology for—particularly for solar PV as well as energy storage, have really—really suggest that we may be able to achieve some of our goals even faster than the—this statutory timeline. In the last several years all of our electric utilities have announced these new projects for renewables paired with long duration energy storage at record-setting prices. The prices have come in around—the most recent solicitation now, eight cents to ten cents for PV paired with storage, and this is four hours of storage. And the PUC just recently approved six of these projects. These compare to our relatively high avoided cost of about 15 cents for electricity generated from oil, which is a predominant fuel here. And these projects are—provide a lot of flexibility for the utility. They provide energy and capacity, but they also provide essential grid services that will enable the utility to de-commit some of the conventional power plants and rely more on renewables.

So, now I'd like to talk a little bit about some of the technical challenges that we're facing here when integrating a lot of renewables. So, we know that there's historically a tendency to focus on the supply side, and this makes a lot of sense, I think, but going forward we see the demand side of the equation as really a critical piece of achieving our goals, especially as we get closer to the 100 per cent target. And I think we've really just scratched the surface of what's possible in terms of shifting and shaping electricity demand using demand-side resources such as energy efficiency, storage, controllable or flexible demand, electric vehicles, et cetera, to enable more cost-effective integration of all the renewable resources that we have.

So, in the longer term Hawaiian Electric plans for about 2400 megawatts of additional distributed PV, and that includes a substantial quantity of energy storage at the distributed level as well. So, this is a remarkable scaling up of demand-side resources and we're starting to see that energy storage is being paired with residential and small commercial PV routinely now. And this is due to several policy changes that we've implemented over the last few years which I'm going to go into in more detail, but the basic takeaway is that between 75 and 80 per cent of all new residential or small commercial PV systems are now being paired with storage and they're going in in Hawaii.

So, here's kind of an oversimplification of some of the integration challenges that we've been dealing with some of the distributed renewables. So, this table comes from a staff paper that the PUC issued a couple of years ago and describes some of these challenges. So, the table is organized in terms of the rows here—system-level challenges, both power system level challenges as well as more localized distribution circuit level challenges. And in the columns you'll see they're differentiated between steady state operations, or normal or typical grid conditions, and contingency events, which refer to unexpected or unplanned events.

And the good news is that in the last several years there have been solutions or mitigations for most of these technical challenges that have been developed and implemented here. And key areas of focus remain the bottom left box, where basically the design of the current distribution system doesn't always accommodate the influx of energy that comes from these customer-sited resources.

And on a positive—a similarly positive note, I think the PUC recently approved a series of grid modernization investments for the utilities to make which will complement a lot of the efforts that are ongoing to address these circuit-level equipment limitations. And I'll talk a little bit more about that too later.

So, we currently have dozens of major electricity proceedings—or dockets, as we refer to them—open on a wide range of issues. And I'll just summarize a couple of the key ones for you right now. So, I think—well, the main one here is at the top: the distributed energy resources proceeding—and the numbers that are below these refer to the docket number themselves, which would enable you to find the materials related to these proceedings on our website. And so, this docket, we've developed new interconnection requirements new distributed resources, as well as new tariff options for customers that want to interconnect. We've also go the demand response portfolio, where we're enabling both competitive solicitations as well as tariff options for procuring grid services from distributed resources, ancillary services. But these resources could include PV and storage but could also include—actual customer loads can provide some of these services as well.

Grid modernization, as I mentioned, we just recently approved the first phase of the utilities investment in modernizing the grid, and these technologies and software that they're—that they will be purchasing and installing will help with the dispatch of customer load, sensing, communications, et cetera, help get better visibility and control out to the edge of the grid.

And finally, we have a new planning process called integrated grid planning, which is just getting underway this year and will continue for another 18 to 24 months from now. We're attempting—the utilities are attempting to integrate the—what was previously disparate planning processes in generation, transmission, distribution, as well as do more accelerated competitive solicitations and procurements for grid infrastructure and grid services, including non-wire solutions. So, this is a very ambitious and challenging effort that's underway now.

So, in terms of the recent policy changes related to distributed energy resources—so, we've developed several new tariffs—or, DER program options—for customers. One we refer to as self-supply. This is a non-export program for customers that would like to have a streamlined path to interconnect, and in exchange they agree to not export back onto the grid. So, these are systems that are designed to offset onsite energy needs with customer generation. And you can do that in a number of ways. That could be managing your load to align with the available generation, or it could involve energy storage to help with that as well. And these systems are designed to minimize or potentially be positive, have positive impact on the grid, and so they get a fast track interconnection approval. And the utilities with the help of stakeholders have developed the technical specifications for—to enable these kind of systems to be interconnected quickly.

The second category is—we refer to as grid supply. And so, grid supply is where—similar to net metering or prior programs where customers, they are allowed to export to the grid when they would like for credit, they can offset their retail consumption through the generation that's coming from their systems and can get credit at the retail rate for that, similar to what Ignacio was talking about—it's a net billing arrangement. And exports are treated as a wholesale energy supply and credited appropriately. But these systems also incorporate the option for the utility to control or to limit export to the grid during emergencies or in times when that would be needed.

And finally, we have what we call the smart export program, and this is for customers who are sure that they want to invest in storage—well, sorry, I should have mentioned for the grid supply option, because the utility has the ability to control or limit the exports when needed, that program is set up for customers who don't necessarily want to invest in storage. But for smart export, that's primarily designed for customers who do want to invest in storage technology. And rather than providing for explicit utility control we use price signals to signal to customers when export is needed or beneficial to the grid and when it would be less desired. So, for example, customers on the smart export program currently would receive no credit for any export to the grid during the middle of the day when we have amounts of high solar already on the system and grid integration challenges are still a concern at that time. However, exports—the credit rate for export is quite high during the peak load period when there's—when we have capacity challenges and we actually need more energy on the system. So, we have the ability to adjust those prices over time as well. And so, as conditions on the grid change we can make adjustments to the pricing and that will flow through in terms of the signal and incentive to the customers.

And on the technical side, this proceeding involved developing new interconnection requirements for DER, including requirements for advanced inverter functions. And given all the growth in distributed PV, we haven't been able to wait for national standards to be updated or adopted, and so we've had to work with utilities and key stakeholders here to identify the most critical needs on the grid, what the capabilities are of the technology and equipment, and implement them through interconnection requirements immediately and incorporate those into our standards here.

So, in particular we've identified that frequency disturbances necessitate wider ride-through settings for PV systems so that they don't trip offline when we have frequency disturbances on our smaller grids. And that was initially the main concern and the highest priority. More recently, advanced inverter functions that help to regulate voltage have been identified as needed and we've made changes to the standards to require that functionality as well, which has the added benefit of making it easier for everyone to interconnect to the system because the voltage issues are—can be a constraint for new customers to sign on.

So, I'm going to talk a little bit about a couple of improvements that we've been pushing our utilities to make. So, one is something called hosting capacity analysis, and the commission here has encouraged utilities to improve their methodology and approach. And this is for how they review and process their interconnection applications. And so, this improvement and a couple of the other ones I'll talk about, I think these have been really helpful for customers, and they've also been helpful in reducing the burden on the utility in terms of the review and processing of these applications.

So, hosting capacity analysis, this is an emerging area. It's getting some attention in some other jurisdictions. And in Hawaii, actually, the stakeholders here pioneered some of these approaches back in 2011 and 2012, but over time I think we've fallen behind some of the advanced analyses that are being done in California and elsewhere, so we're playing a little bit of a catchup. But here's—these slides—or, these are screenshots from a Google Maps type of interface that customers can access, and solar installers can access on the utility's website. And they can easily see and visualize grid saturation issues. And so, there's an image showing the image of Oahu, which is where most of the population is in Hawaii, and you can see the red-shaded parts are signifying areas with very high DER adoption already. And that means that there could be—an additional study would be required or potentially even grid investments or upgrades would need to be paid for by customers to enable interconnection in those areas. But on the other hand, you can see there are a number of areas—in particular, I've zoomed in on the right hand of the slide there—that's Honolulu. That's kind of the urban core. And there's a number of areas in blue and green where DER adoption is not as high, and interconnection should be more streamlined and significantly less costly in those areas.

So, another improvement: The commission required Hawaiian Electric to develop a transparent and publicly accessible interconnection queue. And this lets customers see where their project sits relative to others that have applied to interconnect. And this is a web-based tool as well and they can understand the overall process, and it also helps keep the utility accountable to meet and process interconnections in a timely way. I think this is a helpful thing for both sides as well.

And finally, I just wanted to highlight the commission has asked Hawaiian Electric to develop a good modernization strategy, which they worked on in 2017 and 2018. And the commission has just recently approved phase one of this project, which I think will be really useful going forward to enable further group on the distribution system. So, these are—the grid modernization investment that they're planning to make includes advanced metering of course, but also the sensing and communications infrastructure, the automation and control infrastructure that will enable the utility to better—have better visibility into the grid, especially towards the edge of the grid, and also better control over the grid as well to improve reliability.

So, we just approved this investment, this set of investments, and we would expect that there will be further follow-on as we move into the future.

So, this concludes my presentation and I just wanted to thank you all again for the opportunity to speak with you. And I'd be happy to answer any questions that you may have later on during the webinar. Thank you.

Katie Wonderful. Thank you so much, David. We are now going to pass the microphone and controls over to another David, David Brown, who is the

Principal Distribution System Engineer for the Sacramento Municipal Utility District. So, I would like to welcome David Brown to the webinar. David?

David B. Good afternoon—or evening, depending on where you are. I just thought I'd start out with a brief background of the company that I work for, the Sacramento Municipal Utility District. We're located in Northern California, and one of the great things about it is we have plenty of sunshine. We've got—we're one of the larger municipal utilities. We're not really owned by the city or the county; we're kind of a private entity of the State of California. About 2000 employees. We're just about to finish a feed-in tariff project that's about 150 megawatts that will bring our total up to 460 megawatts of PV.

But I—for this discussion I thought I'd focus on the residential and small commercial solar process, the rooftop solar. Probably about half of our PV is large utility scale fields, because we still have a little bit of land available. But if you can see the slide here, this is kind of what the world looked like when we started. This is a depiction of a neighborhood. Each one of those squares is a lot and the ones with the PV in the middle are the ones that have PV. And you can see there's, like, one per transformer, maybe two per transformer. Life was easy when that was the concentration we were working from. One of the challenges was—when we were working back in those days—we had just gotten this GIS system that came in in 2000. It's been really useful for us knowing what we have and what we're connecting to.

But at present, we're now—let me show the next slide—we've got developments that are virtually 100 per cent solar, and those developments are only going to expand now that the state has passed a law calling for all new homes to have solar—100 per cent of the new housing stock starting next year. So, we're—we went over the past ten years from a utility that was receiving dozens of applications a month to utilities receiving hundreds a week.

I thought I'd discuss the process. It was hit on a little bit in Ignacio's presentation, but the old process we had was we'd get paper applications and we had a dedicated solar specialist reviewing those applications. We even went so far as to put on training classes to train the contractors on how to design systems and how to get their systems through the end of the fast track process. And most of what our tracking back then was for was tracking rebates that we were paying and queueing up customers so that they could get the rebates. We've gone past the rebates now and are just largely interconnecting using net energy metering, which is also on its way out. But anyway, the distribution system planner would review pretty much each application single line, and for a lot of years that was me. And then, we had a dedicated solar specialist that went out and inspected the installations and coordinated with the city building inspector to make sure that what went up was pretty similar to what was applied for. And then, we'd send paper notifications to Billing, and Billing would send somebody out to replace the meter with a two-register meter, and also install a production meter, which is an additional feature that we have I'll show a little later that is I guess a little unique and really useful for us.

Right now, our process is everybody makes online applications—this was discussed earlier. We've taken all the simple installs and handed them off to our new business designers because they're used to working with contractors, and the contractors are used to working with us. My office here now only reviews the installations that are a little bit more complex. We take the ones over ten kW, the ones with batteries, the commercial installations, and anything that the designers look at that they think is going to be a problem—so, if they see a high concentration or any other thing that concerns them, they'll just send it up to us.

We—because we're—on more than 90 per cent of our installations we're setting a separate production meter, and now that we've gone to AMI we don't even have to change the revenue meter. The revenue meter was already a multi-register meter that was bringing us the data. So, those meters don't need change to enable distributed generation or net energy metering, but we are installing on most of the homes and we provide them a production of the PV. Anyway, the process we got does most of the communications and billing gets updated directly.

I know we're not supposed to talk commercial, but the name of the tool we're using is PowerClerk 2 from Clean Power Research. I'd show you their slides but they're all proprietary. So, anyway… The online application allows the customer to go ahead and put in the site information, the host customer's name, the proposed system information. One of the cool things about it is it has a pull-down list that only includes the smart inverters that are approved for installation in the State of California, and it coincides with SMUD's approved list. That gets us the smart inverters that have passed IEEE 1547 and tested to UL 1741 SA, and that eliminates a lot of worries. We just go ahead and hook those up.

And one of the neat things about this program is it calculates the annual output for the net energy metering compliance. Our program limits them to—the applicant to just the same—up to 100 per cent of their annual usage. One of the interesting things about this is it allows the applicant to scan in a recent bill, a layout drawing, and an electrical system drawing. The recent bill serves a couple of purposes. We know what their bill is. But having them submit it shows us that somebody got permission and got ahold of the customer's bill. Now, we don't like to go through this process for people who haven't even sold the system yet. And I'll show you some of these in a minute.

The great thing about this program is it auto-generates status e-mails to the applicant and the contractor so that as they're going through the process they know who's got the ball and who's got the next move. It's really been useful to our customers to know that in spite of what the contractor is telling us it's not the utility—or are telling them it's not the utility that's holding up the game a lot of the time.

This is a picture of a layout drawing. It's pretty simple. They upload it. It gives us an idea of actually where to send our inspector to look. They don't worry too much about the DC side of the system, what's up on the roof. They're more interested in the AC panel. Did the right inverter get installed?

Did the order of the equipment on the wall meet the size and equipment that they said they were going to install?

This is a typical single line that our new business designers look at, and what you'll see here on the left side is the traditional revenue meter, the main breaker of the panel, the distribution breaker that goes out to the solar, and another meter socket—and that's where we put the PV production meter. These are automatic meters, so we can read them at distance, and it's really great when there's a question about the performance of the systems.

The other thing we check is we check simple things for the customer, like did they pick the right size breakers? Did they violate any of the national electric code rules? That way, the process goes much faster once they start building it.

Here's a neighborhood that depicts one that's 100 per cent penetration. And what we've found is—based on our designs—that we can get away with 100 per cent penetration in every home in the neighborhood being about five kW or less. If—in a lot of these developments, when they're—when the developer is putting them on they go a little smaller than that. They stay in the 3.5 range to 4 range. And we don't—it doesn't result in any problems to our system. When we get clusters like this when they're much larger than that is when we have to start getting creative.

We now—and—let's see… So, when we do encounter these higher voltages and start dealing with them, that's when things kind of get fun. We've identified a handful of things that we can do to deal with voltage rise. With many of our customers—it doesn't occur very often, but when it does occur we've used dedicated transformers. We also already require dedicated transformers in residential when the customer has sized their unit over 20 kW, so that takes care of the issue that they might raise the voltage on their neighbors. We can occasionally deal with the voltage challenge by increasing the size of the secondary conductors, and then we can also install voltage-regulating transformers. But they're kind of expensive. We can enable the smart inverters' Volt/VAR functions. As was mentioned earlier, SMUD and the California utilities all require the functionality of Volt/VAR, Volt/Watt, the smart inverter functions, be we're not activating them indiscriminately. We only activate them when we need them because it does have a small annual impact on the customer's power production.

And then, the fifth option, which we haven't used but we're getting so many battery-based systems, that we think we'll be using in the future is just to employ the battery storage during the times of minimum load. And here in California, Northern California, the minimum load seems to be occurring in April, about the second week of April when the sun's on just the right angle, there's no clouds in the sky, and the wind is blowing, the temperature is cool, and nobody's got anything turned on. That's when we get the biggest challenge in terms of dealing with voltage.

What's shown here is a Volt-VAR curve. For those who haven't seen one before or are familiar with it, when you're in this dead band the voltage is in the normal operating range of a utility and we don't ask the inverter to do anything. If the voltage drops low, the inverter can assist by injecting VARs into the system and raise the voltage. And if the voltage is running high, the inverter can draw VARs and lower the voltage on the secondary. And for the most part we're looking at using this just to have the inverter correct for its own impacts on the system. Some of the other utilities in California are investigating whether or not this could also be used to deal with deficiencies on the utility, but that's not really our focus at SMUD. We tend to build fatter wire, shorter feeders, and have very good voltage regulation, so it's—we're not really looking to have the inverter solve our problems.

And here's an example of Volt-Watt. Volt-Watt starts out at running along at 100 per cent and as the voltage gets high it just turns the thing down and turns it off. And the important thing to mention about this is that if this happens four or five or six hours a year, you can effectively double the hosting capacity. And six hours a year of production isn't worth making the investment on dedicated transformers and other pieces of equipment.

I thought I'd throw this slide in to kind of show that point. This is borrowed from the Electric Power Research Institute of Palo Alto, and this shows in the left-hand box that the hosting capacity is exceeded—if you look at the red zone—as the voltage starts getting above the ANSI standard voltage, and that by using Volt/VAR control you can greatly increase that, basically double the hosting capacity. You can see all the points start falling along the line or below the line with this application, and it doesn't take very much away from the native performance of the units. Presently, though, probably about 60, 70 per cent of our units in the field are pre-smart inverters, so we're trying to phase these in. And the best run utilities came up with standard settings that they believe will address most situations. And what we are working with the Electric Power Research Institute—I'm sorry, with NREL, the National Renewable Energy Labs, we're working with them on a program called Precise, and this program allows us to take a look at the system, the topography, and create the custom settings that we would need before the customer shows up so we're not delaying the application process, so we can keep everything moving at a fast track, even when we're reached the first stage of saturation.

And with that, I'll ask if we—I'll pass it on to go through some questions.

Katie

Wonderful. Thank you so much to all of our presenters for those wonderful presentations. As we shift to the question and answer session I just want to ask that our attendees can submit questions again at any time using the question pane. For any questions we don't get to in the remaining minutes we'll follow up with those attendees afterwards. We'll also keep several links up on the screen throughout this Q&A for a quick reference that point to where you'll find information on upcoming webinars as well as previously held webinars like the other DG campaign webinar we recorded back in April, and also how to take advantage of the Ask an Expert program. We've had some wonderful questions from the audience that I'd like to use the remaining minutes to ask.

Our first question came in during Ignacio's presentation. And Ignacio, please address it—or anyone else from the panel, please feel free to jump in. The question was: "Compared to cyber security concerns of centralized power generation, would you say distributed generation is more or less or equally secure as it's been in the past?"

Ignacio Hello. I think this is a very important point as we digitalize our grid, and of course it has to do with a lot of more technologies like IoT. But as—my impression is that with the advance of smart inverters, or inverters in general, this autonomous, self-regulating capacity that they are implementing and they now include, they are self-reliable and they don't require to be basically, I mean, connected through a network to operate. Of course, in a larger system, as David—as both Davids explained, it might be necessary, or it might be prudent to have some kind of a control for DG. But I think in general that might not be the case. And in this sense, it's a lot safer and we avoid a lot of the concerns. I think that's my impression on cyber security for this type of distributed energy resource.

Katie Wonderful. Dave Brown or Dave Parsons, would you like to jump in and say anything more on that?

David B. Yeah, this is Dave Brown. I just thought I'd jump in and say, hey, as long as we haven't connected it all to a distributed energy resource management system—or DERM system—no worries. But that's where we're going. And in the next few years we're looking to connect a lot of these resources either directly or through the cloud so that the utility can access them, and with that comes the same level of cyber security that we use with our large power plants and with our energy management systems.

Katie Great, thank you everyone. Our next question—David Parsons, I'll address it to you, but again, Ignacio and David Brown, if you want to answer as well, please feel free to jump in. Dave Parsons, what is the maximum credit a consumer can receive via smart export?

David P. So, okay. So, there—the credit is calculated based on the marginal costs in the time period that is applicable. And the way that it's been set up, at least initially, is there's a window from 4:00 PM to 9:00 PM which covers sort of the system peak in Hawaii, and the credit in that period is—I believe it's around 15 cents. It varies by island because each island has a different marginal cost, but generally it's between 15 and 20 cents per kilowatt-hour. And then, in the overnight period it's somewhat less, but between 9:00 PM and 9:00 AM it drops down to between 10 and 15 cents approximately, depending on the island.

Katie Great. Thank you so much, Dave. The next question is for David Brown. And during your presentation you mentioned that all new single family homes in California will be required to have PV. Is this something that the utility is ready for the increased number of applications and the timing of how long the process will take?

David B. I hope so. Yeah, we're getting ready for it. One of the things that we did get put into the legislation was the option for developers to opt into a community solar. So, we don't expect all of them will be doing individual. There might be some of them doing community solar, which SMUD is available to provide. But especially if you have developments that don't lend themselves to solar—multistory or ones that are going to have a lot of trees someday—but yeah, it's going to be a challenge. But that was part of our change, so…

Subdivisions aren't tough. They usually design about five, six model homes. We approve the model, and they just cookie cutter it over and over, so that's not going to be a real problem for us.

Katie All right. Wonderful. And I think we have time maybe for one more, maybe two questions. We'll see. For Dave Parsons—and again, for the rest of the panel—are there any key lessons learned regarding DER interconnection that would be good for others to know? Maybe best strategies that have worked better than others?

David P. Sure, I can share a couple ideas. In our experience, getting started early is helpful. The technology changes and the policy changes and the changes in customer preferences, that has all driven very rapid adoption, and I think even experienced and knowledgeable market participants and others here in Hawaii, I think, were taken a little off-guard at just how quickly things have evolved. And so, getting—planning ahead and I think—you know, I've observed some of the jurisdictions on the mainland US that have very low solar adoption so far relatively are already starting to get going on this, so I think that's a great thing to do, just to kind of get this stuff lined up. It also really helps the market develop more smoothly and it's just a better environment for everyone—customers, market participants, utilities—it seems like.

Another thing I would mention is engaging effectively with all the stakeholders is really key. And sometimes this is challenging. It can be challenging in any context, but I think focus and attention on customer and stakeholder engagement can be really helpful. It's not just the solar installers that need to be at the table, but even the customers themselves sometimes, as well as the inverter manufacturers who aren't—don't always participate in regulatory processes necessarily. Getting the utility engineers and everybody to talk through this stuff is really important to having some possibility of agreement and potentially durable, effective solutions.

And then, the last thing I'll say is just it helps to piggyback on the work that others have done. I think California has been a real leader in this area and we've really benefited here by closely following what California has done. And I think where we can—it's not entirely the same, but where we can we try to tailor what we're doing here to match what's happening there. That makes it easier for manufacturers and installers because they are familiar, and then it makes it a lot easier for us and for our stakeholders and for our utilities to have a starting place.

So, there's more, but yeah, I'll stop there.

Katie Wonderful—

David B. This is Dave Brown –

Ignacio Yes—sorry.

Katie No, please, go ahead, Dave Brown.

David B. Okay, yeah, I can weigh in on this one. One of the things that we've seen: the evolution of the inverter from the inverters that were designed to get off the line at the first sign of trouble. It was a really simple inverter and it was really safe. And then, we had more complex inverters that are designed to "don't just make things worse." Now we've got opportunities going forward, and IEEE P2800 is designing inverters that are made for the transmission bulk grid so that they will actually make things better. And I believe the technology has reached the point where there needs to be a diversion between the inverters that are going in on the rooftops and the inverters that are going in the utility scale fields. We can do a lot more, but we can't do it on the rooftops as readily as we can in the larger solar fields. That's one of the pushes that we've recognized, because every time the transmission engineers and the bulk system engineers get together and try to decide what they want the inverters to do, they shut off something we wanted it to do for the distribution system, especially some of the safety features. So, we're been working with the Rule 21 working group here in California to kind of negotiate back and forth over the last little bit, and I think it's a real breakthrough if we get can inverters that are purpose built for transmission interconnection.

Katie Wonderful. Thank you, David Brown. And I think Ignacio also wanted to wrap it up by saying a few—an answer to that?

Ignacio Yes. Basically, I wanted to add on the point of the importance of stakeholder involvement at the earliest stage possible. Basically, the more people you can involve, and especially the agents that are not used to dealing with energy as the end users or the energy markets, I mean, or different aspects, regulatory aspects of utilities as the installers, and so on—and so, everyone has just a part of the picture. And if you bring them all onboard onto the discussion, it's a lot easier for them to understand why from our side, from the policymaking side we are making the decisions, and also taking their feedback and requests to make it better for everyone.

Also, something that was mentioned is that there are some places and some jurisdictions that have had a long experience with these implementations. Of course, there is a lot of challenges, such as the one that we've been discussing now. And it's a really amazing field to be involved in. But we have learned a lot from, of course, from California, also from the studies that NREL is doing with Hawaii on high-penetration impacts. And I think being aware and being involved on a global discussion through these kinds of campaigns and forums is key to share new ideas that could make all our lives easier, let's say, and push for an accelerated implementation of renewable energy and distributed generation.

Katie

Wonderful. Thank you again. On behalf of the Clean Energy Solutions Center I'd like to extend a special thank you to our outstanding panel today and to our attendees for participating and hanging on a few minutes longer than we anticipated. 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 Solutions Center resources and services, including our 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 today's slides and listen to a recording of our presentation today, as well as other previously held webinars. Additionally, you'll find information about upcoming webinars and other training events.

We're now posting the webinar recordings to the Clean Energy Solutions Center YouTube channel. Please allow a few days to a week for the posting to occur.

Finally, I'd like to 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. This concludes our webinar.