[Speaker: Kristen Ardani]

Cover Slide: Good afternoon, everyone. Thank you for joining the Distributed Generation Interconnection Collaborative informational webinar. Today, we are kicking off 2015 with a joint presentation from SEPA and NREL, in which each will discuss recent research and analysis findings related to interconnection.

Slide 2: So really, the purpose of today's meeting is to hear recent research and analysis findings from SEPA and NREL. SEPA used a survey approach to better understand utility interconnection practices, while NREL used system-level data collected through the DGIC to understand the timelines of interconnection process.

Slide 3: So, with that, let's go ahead and look at some of the research findings from last year. And I'd like to introduce Miriam Makhyoun of SEPA. She is a research manager at SEPA, where she conducts market, regulatory, and technology analyses. Her areas of expertise include energy storage, solar energy production forecasting, and interconnection practices. And we're very excited to have her here today to share with us her research.

Slide 4: With that, I'm going to turn it over to Miriam.

[Speaker: Miriam Makhyoun]

Slide 5: Thank you very much. This is Miriam Makhyoun, from Solar Electric Power Association, and I will be presenting some of the findings from a survey and several interviews that SEPA conducted late last summer in 2014, when we reached out to around 400 electric utilities and we heard from 16% of them – or 64. And as you can see in this map, we heard from electric utilities of all types from many different states around the country. Naturally, California was one state that made up 19% of that population of our survey, but we found that we got a pretty robust view of the interconnection challenges and best practices that utilities are facing when integrating more and more solar into their portfolios. Next slide, please.

Slide 6: Utilities receiving 500 interconnection applications a year see an equivalent of around two applications per business day, compared to electric utilities receiving 10,000 applications per year; they may see 40 applications per workday. One example of a utility that sees a lot of interconnections, and they have to process those, is gas and electric, which lately this year has been receiving around 600 applications per business day.

As you can see, the 2013 SEPA market snapshot, where we survey electric utilities on how much solar they interconnect, also found that 5% of utilities were processing 78% of these applications. Therefore, soft cost reductions resulting from improved interconnection processes can have a significant impact on the solar industry.

So, as you can see also, today, more than 86% of utilities are processing fewer than 500 solar interconnection applications. But with the rapid growth of solar, you'll see that we've predicted a million systems estimated by 2017, rising from 475,000 systems interconnected at the end of 2013. It makes sense for utilities that may not have that much solar today to think about scaling their interconnection programs in the future. After all, there are many touch points that the applications have to go through: metering departments, distribution engineering, field inspection, interconnection administration, incentive administration, grid planning, and of course legal.

One utility noted that as the number of interconnected customers has increased, processes have become more streamlined, including the use of smart meters for the remote meter programming and online application procedures. But in spite of that, some of the smaller utilities still prefer one-on-one communication. So, it's a bit of a preference for electric utilities in terms of how they may choose to process these applications. Next slide, please.

Slide 7: So, what are the challenges that electric utilities are facing when interconnecting their distributed generation customers? The number one thing that we found is ensuring application accuracy and completeness. That challenge is predominant in both the commercial and residential sectors. As you'll see, the second-most priority varies between the commercial and the residential installation. The commercial installation, utilities find it's more difficult to obtain signatures, perhaps because there are many parties involved. The second challenge – biggest challenge for residential installations is just communicating with the customers. Residential customers, there are many more of them; they make up probably 93% of all interconnections. And they have a lot of questions about how much energy they'll save with solar and what their bill will be, so that takes some finesse on the part of utilities to make sure that customers are informed and they're kept up to date on when they can expect their interconnection to go through.

Also, many utilities have reported receiving a notable number of interconnection applications after a project has already been fully

installed. And some utilities will deal with this on a one-on-one basis, and in other states there may be regulations that will penalize these customers. So, one electric utility has been very proactive in making sure that all of the installers and third party companies and customers are aware of exactly what it takes to process interconnections – and that's Central Hudson Gas & Electric, which hosts a forum every year for the installers in their area where they get to talk with utility personnel, ask them questions directly, and make sure that they understand the guidelines. Next slide, please.

Slide 8: So, how long is it taking, on average, to process these interconnections? Well, SEPA found in 2008 it took about four weeks. SEPA found in 2014 it takes about four weeks. And NREL is finding the same thing. However, we will talk about how this can be improved with streamlining the process through an online process. But it also is correlated to the number of applications that a utility may process: There's a direct correlation there. For example, utilities receiving fewer than 400 applications a year, well, 41% of them process within two weeks. And this is not including time to build, of course; this is purely approval of the application. And now, utilities who are approving over 500 applications per year, only 15% of them are averaging a two-week turnaround from request to approval to interconnect.

There are many steps in the process. So, the customer has to submit the interconnection application. The utility has to review the application and determine eligibility for net metering or other programs depending on system size and location and interconnection requirements. Studies may also be required to proceed. After distribute – after the DG system is installed, the customer will submit the red line to the utility or the engineering design, and then the interconnection agreement is executed. Finally, you get the permits and there may be an inspection. And then, finally, that electric utility customer will get approval. So, it's no wonder that it could take a while and… But some utilities are tackling the – next slide, please.

Slide 9: To improve the speed of interconnection – which is one of the customer's top priorities, of course – as you'll see, many utilities are starting to incorporate an online platform because they know that they're able to reduce time that way. Time spent communicating with the customers, obtaining signatures, all of those challenges that I mentioned earlier. Only 17% of electric utilities already – that we surveyed – already have an online platform. But many who don't are indicating that they're

interested in it and they're looking into it. But 83%, on the other hand, are either accepting applications through e-mailed PDFs or mailed paper or in person. Next slide, please.

Slide 10: Utilities offering an online application process are able to process two times faster than utilities only accepting e-mailed, mailed, or in-person applications. This process also allows them to collect more details about a system. And when looking at a sample of electric utilities that do process applications on line, 50% - as I've noted – will be able to process in fewer than two weeks. And the average of that – of utilities – is 28% for that same time frame. So, they are noticing that this is making a big difference. And ND Energy, for example, has a pretty robust program where it's noted that this is improving the communication – so, internally within the utility – because there are so many departments involved.

Some of the benefits to an online process is: You can restrict submissions to fully completed applications, and you can prompt applicants when information is missing. When you capture data once, you can eliminate errors. You can autofill forms and documents when you need to reach out again to your customers. You will also be able to give customers the opportunity to track the status of their applications and automate communications, so programs are easily kept informed – program customers. And then, of course, you can store and secure data in databases and make it accessible for analysis, reporting, and operational integration. Next slide, please.

Slide 11: So, many utilities are starting to really collect more operational data as well. But there is a huge correlation – if you have an incentive program at your utility, then you're going to be collecting more information – because that may be required by the state administrator, or the electric utility has determined it's required. Utilities that are not offering incentives of any kind, 28% of them are also not collecting any detailed system information.

The details – the system information that is being collected most often by utilities is inverter manufacturer and model and PV manufacturer and model. The next ones that are being collected is the PV module name plate rating, the quantity of inverters, the inverter name plate rating, and interestingly, SEPA has been working with utilities recently to determine how they are recording the capacity of their systems when they're doing operational systems analyses. And utilities are seeing that – are finding that the inverter rating, the inverter AC rating is an indicator of how much power will ultimately be on the grid. So, this system stack

information is helpful to utilities, not only in managing their incentive programs but also in forecasting system operations. Next slide, please.

Slide 12: So, customers have been telling the electric utilities that they want a simple application process that's well-communicated, quick, with easy-to-understand guidelines. As you'll see, the most needed improvement is application and status transparency. We know this from our data because we asked, "What are your customers saying that they really like about your process? And what are your customers saying needs improvement?" And clearly, customers are really interested in knowing exactly when to expect their systems to come online. And this is certainly something that can be resolved through having an online platform. Public Service Electric & Gas Company is addressing this, for example, by developing an online portal for customers to check status in real time. NV Energy is using PowerClerk Interconnect, which they said is increasing transparency. There are other tools out there that electric utilities are using.

Sometimes, the utilities are building these programs in-house, even. Sometimes, they're shopping them out to a third party purveyor. And, you know, many utilities are disheartened by their customers saying the interconnection process timeline is taking too long. Sometimes, even when it's within a week or two, they'll still get those complaints. So, they feel that they are always trying to improve – the utilities we've talked to say they're always trying to improve, and certainly lower the soft costs associated with processing and the time that it takes. So, next slide, please.

Slide 13: If you would like to just look at the bolded areas of this one, because it is a lot to read, this is directly from our "Distributed Solar Interconnection: Challenges and Best Practices" report. But what this slide is saying is that – in the top left, the blue area – 15% of utilities have just nailed it. They are processing more than 500 applications per year, and in less than four weeks per application. And many of these utilities also have an online platform, which helps with the process.

In contrast, the 28.3% in the lower right-hand red corner, they're processing fewer in a longer time frame. So, there's certainly room for improvement there. And, while – so, essentially, only 15% of utilities have mastered the art of interconnections, while 85% have some considerable room for improvement. And while several utilities said they would like to be able to offer online processing for interconnection applications, only 17% do.

So, taking DG interconnection online does reduce soft costs for the solar industry through simpler application processes and a shorter time to interconnection. And we believe that it also saves money for the utility as well by enabling utilities to handle larger volumes of applications and reducing time spent correcting errors, tracking down customers, responding to customers, or even reporting.

One unique thing that Sacramento Municipal Utility District – or SMUD – does is: It uses a solar engagement platform to let customers know how much solar might be appropriate, because they've noticed that a lot of customers are oversizing their system. So, using an online system is another way to also educate customers about "How much solar is realistic? How much do you really need?" Because there's potential that they might not fully understand the benefits of solar and – without a storage system, especially. So, that's just a really great practice.

Overall, the processes have been improving since people last reached out to utilities about interconnection in 2008. And we are so excited as an organization to be working with NREL through the Distributed Generation Interconnection Collaborative and hearing from everyone in the industry about their frequently asked questions and their best practices so that we can continue on this subject as solar continues to grow, surpassing year-by-year annual additions. Next slide, please.

Slide 14: And with that, I would like to thank the Department of Energy for the SunShot Award that this research was funded by. And we are using information that we collect from electric utilities and the solar industry to stay abreast of soft cost reduction opportunities, and working closely with NREL. Next slide, please.

Slide 15: If you'd like more information, I have a report that is free and public that you can find on the SEPA website. It's called "Distributed Solar Interconnection: Challenges and Best Practices." You can also e-mail me by finding me on the solarelectricpower.org website and ask me any questions. Or, please send me any information about your experience as a utility solar industry member or non-profit research. We would like to be connected to everyone out there doing interconnection.

So, thank you for listening and I look forward to your questions.

[Speaker: Kristen Ardani]

Great. Thank you, Miriam. Very exciting and interesting research. In terms of questions, one of the attendees would like to know if there's a list within the report of the utilities that responded to the SEPA survey.

[Speaker: Miriam Makhyoun]

We did not put a list in the report. I could potentially ask the utilities if any of them would be interested in letting you know if they – that they took the survey. But we let them know that it was confidential and only reported in aggregate. But if you would like to e-mail me confidentially with any questions, or if you're wondering if – about something specific like that, then I can certainly reach out and find out if they would be willing to share. If you're – I'm not quite sure if the questioner is interested in a specific utility. So, just reach out to me specifically about that.

[Speaker: Kristen Ardani]

Okay. Great. And yeah, I can definitely help connect you two especially after the presentation. Also – so, Miriam, you mentioned that communication with customers is a big challenge at the residential scale for utilities. In the survey and other research that you've done, have you unearthed or heard or seen of any new process innovations to address that specific challenge of communication?

[Speaker: Miriam Makhyoun]

Yes. There are some software tools out there that will keep a customer abreast of the latest engagements that a utility is making and in processing an application. Clean Power Research, West Monroe Partners, and other companies are producing this type of software.

[Speaker: Kristen Ardani]

Great. So, along those same lines, a similar question here: What are some – and this, I think, is not just specific to communication but for the whole interconnection process in general – where do you see the biggest opportunity for improvement? And along those lines, what are the most innovative improvements that you've seen or have heard are coming online in the near future?

[Speaker: Miriam Makhyoun]

Okay. Well, I think that – like I was saying about Central Hudson Gas & Electric – upfront communication, making sure that installers understand what a utility expects is one of the best ways

to ensure a smooth process. And also, just the application status transparency is what the – is the biggest issue for customers. And then, the biggest issue for utilities to customers is getting the correct information. So, I think, you know, just having that online platform that interacts with customers and doing a good job of interfacing with installers, it may not be extremely innovative but it's practical and it works.

[Speaker: Kristen Ardani]

Great, Miriam. Thank you. I think we can do one last question before transitioning to the next presentation. And that – here, let's see here – this question has to do with the inspection process specific to the utility inspections – maybe also referred to as witness testing – that were covered in the reports. Did you find that utilities are requiring inspections more frequently with higher PV penetration, or that inspection also falls under this category of opportunity to streamline, in that utilities may be requiring fewer inspections? Did you see any trends there with whether inspections prior to issuing final authorization are becoming more common or less common as we see higher PV penetrations on the grid?

[Speaker: Miriam Makhyoun]

I actually would probably direct that question to you, Kristen, since you analyzed the specific points in the process and SEPA's research is only looking at the application process. But in general, most of those inspections – I did hear from utilities who say they do random inspections of smaller systems. But for larger systems, many utilities will require an inspection – and maybe even a study fee – for something over a couple of megawatts, for example. But I think that this might be a good time to refer to you and your research.

Slide 16: With that, I'd like to introduce Kristen Ardani, who was just fielding the questions for me. I'm going to turn over the presentation to her.

Kristen Ardani is a solar analyst at the National Renewal Energy Laboratory. She develops and executes economic market analysis of renewable energy technology, with a focus on photovoltaics, including PV non-hardware balance of system cost, deployment pathways, and market transformations. Kristen?

[Speaker: Kristen Ardani]

Slide 17: Great, Miriam. Thanks. Well, that was a really interesting way to transition. I think there might be a few additional questions around

the inspection and other interconnection processes at the end, so what I might suggest is: Let's hold all further questions till the end of this presentation and then we can have a longer Q&A discussion.

So, with that, I'm very excited to share this research with the group today. This research – for this research, rather, much of the data was sourced directly from DGIC members, participants, and advisors, and was a very collaborative effort in terms of aggregating the data, collecting the data, and identifying: Where are the priorities for data collection and analysis?

And so, for the first year of the DGIC analysis portfolio, the advisory team stated that it would be important to look at the timeline for interconnection, that there was a need in the marketplace to better understand how long the whole process takes. And the SEPA research definitely does a really elegant job of elucidating the application process and what utilities are undertaking as they see higher volumes of applications.

And this research builds upon that in many ways by looking at PV system-level data to better understand how long this interconnection takes. And this will be from a forthcoming paper that should be published here within the next few weeks, and the report will be titled, "Highlights –" pardon – the report will be titled, "A State-level Comparison of Processes and Timelines for Distributed Photovoltaic Interconnection in the United States." And today, I'm just going to highlight a few of the key findings of that forthcoming report for the group. And I also just want to say thank you to everyone who has participated in this project.

So, I'm going to briefly walk through the purpose of the project, the approach – and touch a little bit on the methodology – and then do a quick overview of the PV approval process before diving into some of the key analysis results. So first, we'll look at the timeline for total days for utility interconnection, and then we'll break that out into the business days for each stage. And specifically, we'll look at the application review and approval stage. I'll cover a little bit about the timeline requirements in each of the states that we looked at; that is, the time requirements for the utility to finish the application review and approval, and then, how each state's data compares to those timeline requirements.

Then, we'll cover the PV construction and final building inspection timeline results before concluding by looking at the "permission to operate" process and how long is it taking in the marketplace for

installers to receive final authorization to interconnect. And similar to the approach for application review and approval, I'll briefly highlight some of the timeline requirements in each of our states for that PTO operate, and then summarize with a few key high-level conclusions.

Slide 18: So, really, the purpose of this project was to understand interconnection and deployment timelines for distributed PV. And as part of this process, the research team evaluated the portion of projects that exceeded one month for either the application phase of the final authorization to interconnect phase. We looked at this one month cutoff because typically in a given state the PUC will mandate that the application and/or PTO process should be completed within 15 to 20 business days, unless that project requires some type of detailed or other impact study.

Slide 19: So, we look at our state-level data. We compare it to the timeline regulations in each state, and the main objective being to look at – at the system-level, do an analysis of actual projects installed.

So, in terms of the approach and the methodology, we collected system-level data for more than 30,000 PV systems installed across 87 utilities in 16 states. Most of the projects examined were installed in the 2013 time frame, and we segmented our data sample into residential projects – which we defined as up to 10kW – and small commercial – 10 to 50kW. So, we're really looking at residential and small commercial projects, most of which are eligible for some type of fast track review process in each of our key states analyzed.

So, in building out the approach a little bit further, we really wanted to quantify the time duration for discrete stages of the interconnection process. And we looked at the total days for utility interconnection and then broke that out into the application, process, the actual time to construct the PV system, and then the time required for the final building inspection and paperwork submittal process to the utility. And then, lastly, like I mentioned, the final utility authorization for interconnection, also known as "permission to operate."

Slide 20: So, this graphic shows that there are two separate approval processes for PV deployment. So, one is from the local permitting jurisdiction, which oversees the construction and building permitting, and another for the electric utility, which oversees interconnection approval. So, PV projects must receive approval from both the permitting jurisdiction and utilities for operation.

So, this analysis does not include the early stages of building and construction permitting here – denoted in gray – but rather, focuses on the time required for the utility interconnection approvals, and also touches on the PV construction timeline and building inspection approval. So, really, we're capturing about half of the local permitting process and, to the extent possible, the full utility interconnection approval process.

So, just to highlight that there are many areas of the country that don't have specific building departments – say, in smaller towns and rural areas – and so, they will rely on the state inspectors and state guidelines for building inspection. So, for example, Colorado has many counties like that. And that there are more than 190 investor-owned utilities, 2,000 publicly-owned utilities, and 870 cooperatives in the United States. And so, PV developers really encounter a wide variation in interconnection fees and requirements. And then, you couple that with a lack of standardization in building permitting and inspection processes across more than 18,000 authorities having jurisdiction, and that can further slow PV deployment.

And I'd also like to highlight that the level of coordination between these two processes varies by municipality and utilities. In some places, they're very coordinated. But in other places, they really are separate and parallel processes.

Slide 21: So, we tied that overall process and put together a graphic that depicts the timeline analysis metrics used in this analysis specifically. And there, you can see we really do focus on the utility interconnection approval processes with respect to the application and PTO, but also the two intermediary processes of PV construction and the local jurisdiction building inspection. And we look at the business days to complete each of these discrete stages of the process.

So, with that bit of background, I'd like to dive into some of the key analysis findings, starting with the total days required for utility interconnection. So, this metric measures the number of business days from the date a PV installer submits an interconnection application to the utility to the date the installer receives final authorization or PTO. And to note that this period is only calculated for systems for which the installer submitted an application for interconnection separately from the final paperwork for PTO.

Slide 22: So, for example, for smaller projects in California's three largest investor-owned utilities, investors actually have the option of submitting the application for interconnection and PTO paperwork together after completing construction and passing all AHJ building inspections. And so, in doing so, these utilities essentially combine the application and PTO paperwork into a final step that streamlines the interconnection process for residential and small commercial systems. And they really do this because those are systems are not likely to cause an adverse grid impact.

So, here you can see the median across the full sample for projects that submitted applications separately from PTO, with 53 days for the full sample. And the table below breaks out the sample by residential versus small commercial, and we can see that the median is about 10 days longer for small commercial projects compared to residential, which one would inspect given the larger nature of the project: It would take longer for PV construction. Perhaps there are some other types of studies or reviews that are necessary for these larger projects.

But we really do see a range across the key states that we examined. And we can see that California did have amongst the fastest total timelines for utility interconnection approval, with 50 – a median of 50 days across the approximately 6,000 systems that we examined in that state. And that might very well link back to the fact that California has made significant efforts to streamline the process overall.

Slide 23: Okay. So, moving on to breaking out the discrete stages of the interconnection process and how long each one takes: On the far right-hand side of this graphic, you can see the same data that we just showed for total. And now, we have the application broken out versus the PV system construction, inspection, and PTO. And we have the sample sizes there, denoted with the median for the full sample for each of those stages.

So, kind of getting back to "How do PV interconnection processes – or, rather, the systems that are installed according to a certain process – compare to a time frame for installation?" Just to get a sense for this, we can see that for the application review and approval stage, approximately half of all the systems that we sampled took 20 business days or longer, and that the median time frame for those projects that longer than 20 business days was 38 days for residential sample and 39 for small commercial. So, we can see that it's taking about 18 days longer than 20 for both system sizes examined.

And I'd also like to note that in looking at this chart, total days isn't necessarily equal to the sum of these four individual project time frame components. I simply put this graph together to sort of highlight how we've broken down the process, but these steps are not additive on account that there could be additional process steps or overlaps in the process steps that we included here.

So, now that we have that higher-level snapshot of total time for interconnection approval and the discrete stages, let's look specifically at the first stage for application review and approval.

Slide 24: So, for each of the key states, we considered the unique system size criteria for interconnection and the corresponding time frame requirement. So, for example, under California's Rule 21, all projects up to two megawatts in size are eligible for fast track processing. Whereas, say, if you looked at Colorado and New Jersey, they both allow for two separate tracks based on system size and complexity: level one for up to 10kW and level two for systems up to two megawatts. New York also has two procedures, but with different size thresholds.

And so, we really look at the unique interconnection track in each state and the timeline requirements for the application review and approval process. And I'd like to note that we did include Arizona in our state level analysis, and we compare application review and approval process timeline to an ideal threshold of the 20 business days I mentioned earlier, because currently in Arizona there are no state-level requirements in place with respect to how long a utility has to approve and review applications and process interconnection requests. So, this is a snapshot of the regulations that are in place for application review and approval by states.

Slide 25: Now, when we look at each of the key states and how they compare to each other and compare to the given regulation in each state, here you can see the difference amongst the states for Arizona, California, Colorado, New Jersey, and New York. And then, on the far right hand side, the full US sample – so, we compare each state to the full US sample. And in the red line you can see – that is the regulation for the size and state when applicable. So, note that Arizona doesn't have a red line, because Arizona currently has no mandate in place for a timeline.

Again, all project samples meet the system size eligibility criteria for simplified or fast track review in these states. And of the states examined, New York demonstrates the lowest median number of

days for PV system application review and approval, followed by New Jersey, then California, Arizona, and Colorado. I noted specifically that there is a 22-day difference between a typical median residential project in New York and Colorado, and this could indicate the effectiveness of state-level regulations. So, for systems up to two megawatts – from the previous slide – New York utilities are required to complete application review and approval in 10 fewer days than are Colorado utilities. However, even with a more aggressive timeline requirement in place in New York, there were still many projects in that state that exceeded the prescribed time frame. And we can look a little bit closer at that now.

Slide 26: So, this table provides additional detail giving the total time requirement for utility application completeness review and initial screening – that is, the total time required – the percentage of applications that exceeded the time requirement, and the median application review and approval time for those projects that exceeded. So, again, going back to the comparison of Colorado and New York from the previous slide: You can see here that in Colorado 58% of residential and 45% of small commercial project samples exceeded the mandated time frame of 25 days and 30 days respectively. So, for those installations, the median time to complete the application process was 50 days for the residential sector and 59 days for the small commercial sector.

And then, looking at New York – just taking another example to walk us through this table a little bit – in New York, 38% of all projects sampled exceeded the prescribed time frame of 15 days, and the median time to complete the application review and approval process for these projects was 49 days.

So, you can get the gist of how we have broken up this data by size, state, and specifics to each of the states' requirements to get a feel for the rate of compliance, if you will. And we did note that with the exception of California and Arizona, for projects that exceeded regulated time frames there are longer delays for small commercial projects compared to residential. So, a typical small commercial project was delayed by an additional 9-11 business days.

Slide 27: So, moving on through the process, here I have provided a graph of the analysis results for the PV construction and inspection. And when I refer to inspection, we're really talking about the final building inspection that is completed at the jurisdiction level, be it

the city or the county or, in some cases, both. And you have box and whisker diagrams depicting the data for these two processes.

So, the blue graph here for PV construction: We find that PV construction takes the shortest amount of time of the process days examined, with a median of two days for residential projects and a median of four days for small commercial projects. For across the full US sample of approximately 26,000 systems that we looked at, the median time frame was two days.

So, it's also kind of curious to note that these results may actually overestimate construction time in terms of actual labor hours worked, because the level of data that we captured and collected really focuses on the complete business cycle – from the date construction started to the date construction was completed. And so, half days worked or the exact labor hours for construction are not actually captured here.

And then, in terms of the final building inspection, this time frame includes the full process of scheduling the inspection, completing the inspection, and then, getting all of the required paperwork for permission to operate collected and sent to the utility. So, after a PV system is constructed and passes final building inspection, it then must send proof of past building inspection to the utility so that the utility can review that it has passed its building inspection and can then issue authorization to interconnect – again, getting back to the two parallel processes of approval to PV.

And so, we can see here that for that full process, including from the time it takes the scheduler to send all the paperwork to the utility, the median was four days for both the residential and small commercial, with the actual inspection taking approximately one day. So, really, PV construction and inspection aren't necessarily identified in this analysis as huge bottlenecks to the PV, but rather two processes that take some of the shortest time frames seen.

So, moving on to the last page of the interconnection process that we looked at: This is final – this is final authorization, other known as "permission to operate." And so, similar to application review and approval, I'm just going to start by outlining a few of the time frame requirements that we compared the data against, and that is the time frame requirements by which the utility had to issue PTO, from when a complete set of paperwork is received.

Slide 28: So again, in this table you can see state-level requirements by system size and interconnection track. And generally, PTO

regulations for PTO time frames are flexible to allow for additional utility witness testing and inspection prior to authorizing an installer to energize a completed PV system. So, for example, in New Jersey, for systems up to 10 kW, utilities must issue a PTO letter within five days if the utility inspection is waived. But they're allowed up to 20 days if the witness testing and/or additional inspections are required by the utility. These time frames increase by five days for systems up to 2 megawatts in that state. Meanwhile, Colorado has the same regulations for all systems up to two megawatts: five days if inspection and/or witness testing is waived, but 10 days if inspection or witness testing is not.

So, for the purposes of this analysis and assessing the portion of projects that exceeded regulated PTO time frames, we used the higher of the two cutoffs to account for any potential but allowed final utility inspections. So, we really are using a rather high threshold when evaluating the percentage of projects that took longer than the prescribed time frame; that is, this time frame established by the PUC or state level.

Slide 29: So, here you can see a graphical depiction of the results for the residential sampling, and you can see the difference between the actual PTO days and the state time requirements again denoted with red lines for the states of Colorado, New Jersey, and New York. And as shown in these figures, New York has the lowest median number of days to issue PTO – six for the residential and small commercial samples – of all the states examined. It also has the shortest application review and approval timeline. It's followed by Colorado, California, New Jersey, and Arizona.

So, in looking at the difference between New York and Arizona, Arizona doesn't necessarily have any state mandates in place for PTO time frames, and median completion times in New York are faster. And those results are statistically significant. But I just want to highlight that the differences in PTO time frames between Arizona and the other two states with PTO regulations – Colorado and New Jersey – the differences are minimal and they're actually not statistically significant. So, while this indicates that the adoption of state-level time frame requirements could lead to overall lower processing times, other factor must be considered when identifying causes of variation between states. Certain factors could include difference in utility processing and tools, witness testing requirements, and other factors related to goal setting and tracking.

Another interesting finding here is that when looking out in California – a state that allows installers to submit application and PTO paperwork together following construction instead of following this more traditional process of applying for interconnection applications first, and then inspection, and then PTO paperwork – we really didn't see a material difference when comparing the time for PTO for projects in which the interconnection application and PTO paperwork were submitted separately for the typical process versus those in which the application and PTO paperwork were submitted together.

So, what this means, really, is that we don't really see any – call it variation or statistical significance in evaluating if submitting them together would slow the overall time frame. We really don't see a material difference or statistically significant result there.

Slide 30: Now, just looking at all five states – again, the time requirement for utility PTO and percentage of projects that exceeded the time requirement – this table is set up very similarly to the application review and approval table. And just as an example, we find that 53% of residential projects in New York exceeded the PTO regulation of five days. And for these projects, the median completion time for PTO was 11 days – so, more than double the regulation. And that's more than half of the residential projects that we sampled. Meanwhile, in New Jersey, 23% of residential projects exceeded the PTO regulation of 20 days. And for these projects, the median is 28.

So, we will be able to look at these findings in more detail at a later point when the report is released, but I just wanted to give an overview of the methodology, how we are looking at the data, and the type of analysis that we performed.

Slide 31: So, with that, I just want to leave the group with a few high-level conclusions of this work. And just taking a step back overall, I really think that we see evidence that while regulations may reduce overall completion times, we really do see that a large percentage of projects don't necessarily meet that deadline set by the regulations. And of all that we examined – similar to some of the SEPA findings – application and review and approval and took the longest of the phases we looked at, along with final authorization taking the second longest time frame.

And really, what we see in this dataset is this "go/no-go" market dynamic. It's really a dichotomy between applications that are reviewed and approved quickly versus those that are delayed. And

so, if you look at the fact that half of all the systems sampled took one month or more for application review and approval, as an installer you're looking at the fact that if you can make it through the process within a relatively quick, swift amount of time, the delays that you can anticipate are relatively minor. But if you're delayed, you're delayed by more than double what the state time frame is laying out, just at a very high level.

Slide 32: Okay, so with that, I'd really like to open it up to questions and discussion and thank two of my co-authors here at NREL, Carolyn Davidson and Robert Margolis, and the DGIC group for helping to source and provide the data for this research. We really hope it can be used to identify potential areas for streamlining or improvement in the process, and areas where communication between PV developers and utilities can be improved so that utilities are spending less time and money on interconnections, and that PV installers and the customers are walking away with a relatively satisfactory interconnection experience, if you will.

And so, I also want to give a special thank you to Miriam for joining us and presenting the SEPA research today, and to Courtney for helping and facilitate and moderate, and to all of our participants. Thank you so much.

[End of Audio]