Building Blocks for Distributed PV Deployment, Part 1: Goals, Definitions and Compensation

—Transcript of a webinar offered by the Clean Energy Solutions Center on 10 May 2018—
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Webinar Panelists

Alexandra Aznar	National Renewable Energy Laboratory
Naïm Darghouth	Lawrence Berkeley National Laboratory
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Katie

Hello, everyone. I'm Katie Contos. Welcome to today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with USAID Distributed PV Program. Today's webinar is focused on Building Blocks for Distributed PV Deployment, Part 1: Goals, Definitions, and Compensation.

Before we begin I'll quickly go over some of the webinar features. For audio you have two options: you may either listen through your computer or over the telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option and a box on the right side will display the telephone number and audio PIN you should use to dial in. If anyone is having any technical difficulties with the webinar, you may contact the GoToWebinar's helpdesk at (888)259-3826 for assistance.

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Finally, one important note to mention before we begin our presentation is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center resource library as one of many best practice resources reviewed and selected by technical experts.

Today's webinar agenda is centered around the presentations from our guest panelists, Alexandra Aznar and Dr. Naïim Darghouth, who have joined us to discuss the Building Blocks of Establishing a Distributed PV Program. Before we jump into the presentations I'll provide a quick overview of the Clean Energy Solutions Center. Then, following the panelist presentations we'll have a question and answer session where the panelists 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 and the European Commission are members, contributing 90-percent of clean energy investment and responsible for 75-percent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government policymakers design and adopt policies and programs that support in the deployment of clean energy technologies. This is accomplished through the support and crafting and implementing policies related to energy access, no-cost expert policy assistance, and peer-to-peer learning and training tools, such as this webinar. The Clean Energy Solutions Center is cosponsored by the governments of Australia, Sweden, and the United States, with in-kind support of the government of Chile.

The Solutions Center provides several clean energy policy programs and services including a team of over 60 global experts that provide remote and in-person technical assistance to governments and government-supported institutions, no-cost virtual webinar trainings on a variety of energy topics, partnership-building with development agencies and regional and global organizations to deliver support, and an online library containing over 5,500 clean energy policy-related publications, tools, videos, and other resources. Our primary audience is made up of energy policymakers and analysts from governments and technical organizations in all country, but we also strive to engage with private sectors, NGOs, and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across its suite of different programs. Several of the partners are listed above and include research organizations like IRENA and IEA and programs like SEforALL and regional-focused entities such as ECOWAS Center for Renewable and Energy Efficiency.

A marquee feature that the Solutions Center provides is a no-cost expert policy 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 finance we are very pleased to have Toby Couture, founder and director of E3 Analytics, serving as one of our experts. If you have a need for policy assistance in finance or any other clean energy sector we encourage you to use this valuable service. Again, this assistance is provided free of charge. If you have a question for our experts, please submit it through our simple online form at cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations.

Now I'd like to provide a brief introduction for today's panelists. First up is Alexandra Aznar, who is a Project Leader at the National Renewable Energy Laboratory in Golden, Colorado. She works on clean energy policies and provides solar technical assistance to local state and national-level policymakers. She leads an implementation of the USAID Distributed PV Toolkit.

And our other speaker today is Dr. Naïm Darghouth, who is a Senior Scientific and Engineering Associate in Electricity Markets and Policy Group at Lawrence Berkeley National Laboratory. Naïm conducts research and analysis on renewable and energy policy, both US and international, including electricity rate design and its impact on the value of residential renewable energy systems, economics of renewable energy technologies, and federal and state energy policies.

And with those very brief introductions I would like to welcome Alexandra to the webinar.

Alexandra Thank you, Katie. Welcome to the United States Agency for International Development, or USAID, and National Renewable Energy Laboratory, or NREL's webinar series on distributed photovoltaics. My name is Alexandra Aznar and I am a project leader at NREL, and today I am going to be talking about the building blocks for distributed PV deployment in developing countries.

So, please note that this is the first webinar in a two-part series on Distributed PV Building Blocks. So, please join us in two weeks for the second half of the series, when we focus on Interconnection and Finance in Business Models. In addition to this webinar series, NREL supports the USAID-distributed PV pilot program, the objective of which is to help USAID partner countries address barriers to safe, effective, and accelerated deployment of DPV. This USAID DPV pilot program is a multi-year effort that will build capacity in partner countries through pilot projects targeted to specific technical policy and regulatory _____. If you're interested in this program, please reach out to the contacts listed here and at the end of the presentation for more information.

At the end of this presentation we hope you'll have a good understanding of what makes distributed PV, or DPV as well refer to it throughout the presentation, distinct from utility scale systems and which foundational elements should be in place to lay the groundwork for a success DPV program and deployment.

Today I will begin by giving a brief overview of DPV basics before moving on to the foundational elements or building blocks for deployment. Throughout this webinar series we will refer to distributed photovoltaics, or DPV, and distributed solar interchangeably. Much that we discuss also applies to other forms of distributed generation, or DG, but the focus will be on DPV because it is the most common form of distributed generation. When we speak of DPV we are referring to systems connected to the distribution network of an established, centralized utility system. We do not cover microgrids or DG for electrification purposes, i.e. off-grid systems, in this presentation. Additionally, we are referring to systems that are smaller in scale, for example, less than one-megawatt, and typically connected behind the meter of retail electricity customers. In most cases these systems are not owned or operated by the distribution utility, although we will refer to some new business models in which utilities do own DPV systems.

So, in the previous slide I referred to behind-the-meter systems. What does that mean? When a DPV customer installs a system, they assume three distinct roles: retail customer, sales provider, and power exporter. This graphic illustrates this dynamic. Along the x-axis is a customer's load by hour in a typical day and on the y-axis is the energy consumed. In the early hours of the morning, when it's still dark outside, a DP customer consumes electricity from the grid like a regular retail customer, because their DPV system does not generate electricity at night without the sun. As the day goes on the DPV system starts to generate electricity that is consumed on site. At mid-day the DPV system may produce more electricity than a customer can consume, so excess power is exported to the grid. In the evening, once again the DPV system does not generate electricity and the customer consumes electricity from the grid like a regular retail customer. The phenomenon I just described is important to understand because of its implications for customer economics, utilities, and other ratepayers, issues that we will unpack later in this webinar series.

Another important concept to understand when it comes to DPV is the difference between hardware cost and "soft" cost. Hardware refers to the DPV system module, inverter, and structural and electrical components. Soft costs refer to less tangible costs such as permitting fees, installation, labor, and customer acquisition costs. Soft costs can contribute significantly to the overall cost of a DPV system. While hardware costs continue to decline globally, some soft costs remain stubbornly high in some jurisdictions. This chart, which is dated 2013, compares soft costs in the US and Germany, and as you can see, these soft costs contribute to a much larger percentage of a DPV's systems overall cost in the US than in Germany. Soft costs will vary depending on the jurisdiction. The distinction between hardware and soft costs is important because each type of cost may require different approaches and policies to reduce them.

When a customer deploys a DPV system and interconnects it to the distribution system the interactions between the distribution utility and DG owner reverberate, potentially affecting other ratepayers who may or may not own DPV, the grid system as _____. DPV issues, particularly as cost and benefits, can be approached from various stakeholder perspectives, and we will be exploring these various perspectives throughout this webinar series.

The reason we are delivering this webinar series and why energy stakeholders all over the world are discussing DG and DPV is because it is a unique technology that provides a lot of opportunities as well as challenges. For example, DPV is an opportunity in the sense that it can be rapidly deployed and provide much-needed capacity to power systems around the world from a new source of investment capital, i.e. not necessarily utility and rate payer-funded. DPV also represents a method of empowering electricity consumers and improving the environment through reduced air pollutant admissions. This opportunity also becomes with challenges because DG challenges how we plan, operate, regulate, and even conceptualize the power system. Why do we say "conceptualize"? Well, when customers adopt DPV power may flow backwards. Customers are becoming actual investors and electricity market participants and utility business models are being challenged. DPV costs are declining substantially, making DPV more accessible, and this is creating a range of issues and opportunities spanning technical, regulatory, policy, and legal domains.

A final important message I'll leave you with is that people are no longer waiting for these issues to be resolved. The technology is accessible enough, affordable enough in many places, and easy enough to install. In some places this is leading to untracked systems and unregulated metering and substantial safety issues for line workers and the communities. It's important for energy stakeholders to get ahead of these issues by proactively setting up clear, safe, and appropriate policies.

That brings us to what we call the building blocks for DPV deployment. This schematic shows the DPV building blocks and their relationship to each other. The first building block is vision, goals, and role. Policymakers, regulators, utilities, and other relevant energy stakeholders should consider what the role of DPV will be in a country or region and which institutions will be responsible for specific activities. The second building block is defining what distributed generation is in your specific context. DPV is after all a specific DG technology. After that, creating a compensation mechanism for DPV is important. The compensation mechanism has three main components: a metering and billing arrangement, a sell rate, and a retail rate. It also has implications for utility costs and risk allocation.

The metering requirements feed into building block number four, interconnection processes, standards, and codes that dictate how a DPV system can be connected safely, reliably, and expediently to the grid. The compensation mechanism and interconnection processes, standards, and codes come together in a standard interconnection contract, an agreement between a customer with DPV and the utility.

Building block number five is public policy support. Public policies, including financing and business models, can create additional incentives and pathways for DPV deployment. In the second part of this webinar series we will dive deeper into specific build blocks, but today we'll focus on the first three.

Building block number one is defining your vision, goals, and roles for DG, and thereby DPV. A vision and goal helps guide DPV deployment, set expectations, and reveal key issues that must be addressed. In the left-hand column of the schematic we pose a few questions that may help policymakers, regulators, utilities and the like clarify their vision for DPV. For example, what is the desired role of DPV in the electric system? Do you consider DPV as a source of electricity customers use primarily or exclusively for self-consumption? Or do you consider it a new source of energy and capacity to help you meet load growth? Answers to these questions will have implications for how you define DG and may influence limits imposed on the size of DPV systems.

Who can own DPV systems? This question gets at the roles different energy sector players have when it comes to distributed generation. Around the world we see individual consumers, third parties, utilities, and entire communities owning DPV systems. But some jurisdictions restrict ownership to only certain entities, depending on their policy priorities and their regulatory framework. DPV ownership has implications for types of financing and general accessibility to DPV. Who can install DPV is a similar question to the previous one. The answer will have implications on DG business models. The final question on the far left-hand column points to how DPV deployment might unfold across different customer classes. Is it advantageous to see DPV deployment in certain customer classes over others? The answer to these questions influence how retail electricity rates are designed and across subsidy effects that may play out as DPV deployment grows over time. Again, these questions are just examples of how one can explore a vision, goals, and roles for distributed PV in a specific jurisdiction.

The second building block is defining DG. Now earlier in this module we defined DG and DPV as a system smaller in scale, connected to the distribution network and behind a customer's meter. That general definition of DPV and DG largely holds worldwide, but jurisdictions can further refine their definitions of DG. As you can see from the examples on this map, definitions of DG vary around the world. Some definitions remain broad, while others have specific system size caps or production limits. Sometimes grid codes already have a definition of DG within them. Other times grid goals need to be modified to exempt certain DG generators from expensive compliance measures that are designed for larger systems.

So, we just reviewed and explored DPV building blocks number one and two. Now I'm going to turn it over to my colleague, Naïm Darghouth, to walk you through building block number three, compensation mechanisms.

Naïm Great. Thank you so much, Alex. Again, my name is Naïm Darghouth. I am in the Electricity Markets and Policy Group at Lawrence Berkeley National Lab. And I have been collaborating with my colleagues here at NREL on a number of projects, including this USAID project. Today I'm going to be talking about the compensation mechanism basics for grid connected distributed PV, and you can find more on this subject in a recent whitepaper that we put out and I'll be linking to in the final slide.

So, a few of the learning objectives. So, at the end of this webinar I hope that some of the key concepts related to PV compensation mechanisms will come through towards these learning objectives. So, the first one is to better understand why PV compensation mechanisms are so central to the economics of PV to both the customer as well as the utility and so how it can affect utility finances as well as retail electricity rates. Next, we're going to want to be able to understand what the three main elements of PV compensation mechanisms are, and we'll be describing the three key net metering and billing arrangements, which include net metering, Buy all, Sell all, and net billing. And finally, we're going to compare the benefits and challenges associated with those metering and billing arrangements.

So, let's start with the basics. What is a compensation mechanism and why is it important? So, a compensation mechanism is the instrument designed to award a distributed PV customer for their PV generation. Electricity generated by a distributed PV system only has two ways to go, either it can be consumed on site or self-consumed to serve the customer's load or exported to the electric grid. A PV compensation mechanism defines how each of these two types of PV generated are to be compensated, therefore it determines the economic value of the PV system to the consumer. For example, the total bill savings or payments for electricity generated over the lifetime of the PV system. Conversely, it also determines how much reduction in revenue or payments the utility needs to make for this distributed PV generation. So, it determines the value proposition to the customer, but it also determines the costs for that generation to the utility.

So, beyond determining the value of the PV generation to the customer, compensation mechanisms also help determine whether distributed PV is going to impact retail electricity rates for all as well as utility earnings. So, remember that the compensation mechanism determines what the cost of the distributed PV generation is to the utility for both the self-consumed electricity and that which is exported to the grid. If those changes are not commensurate with the value of DPV to the utility, then the difference between these two must either impact utility earnings or profits or impact the level of the retail electricity rates to all customers.

Now that we understand why compensation mechanisms for DPV are important, let's dive into the components of the compensation mechanisms. So, there are three main parts to a compensation mechanism. The first is the metering and bill arrangements. So, this defines how consumption and generation-related flows are measured and billed. So, for example, is DPV generation, which is exported to the electric grid, paid at a fixed rate or is it counted as a kilowatt hour credit for the consumer to use at a later time? If it is a credit does that credit ever expire? To make it simpler to understand what the options are for the metering and billing arrangement I'm going to be classifying them into three main types of metering and billing arrangement. The first is net energy metering, the second is Buy all, Sell all, and the last is net billing. And we're going to go into more detail in the next few slides, as these really provide the structure for the compensation mechanism.

The next component is the sell rates design. So, this element defines the exact level of compensation a DG system owner is going to receive for that electricity, which is exported from the DV system to the utility grid. The sell rate applies to distinct quantities depending on the metering and billing arrangement that's selected. So, these sell rates can be static, which means they remain fixed over the length of the interconnection contract, but they can also be more dynamic in nature, changing with time or by location with various degrees of granularity.

And finally, the last element which is needed to fully describe a PV compensation mechanism is the retail rates design. So, this component defines the retail tariff structure and exact purchase rates that the DG system owner must pay for the electricity from the grid, and hence what costs the DV system owner can avoid if they self-consume the electricity produced by their DV system. This element, of course, is going to be only applicable when the metering and billing arrangements allow the customer to self-consume their DPV generation in the first place. This is not the case with the Buy all, Sell all plan, as we're going to see in just a couple of minutes.

So, other than the three main components there are some other important components to consider for compensation mechanism and these are highlighted here. So, there's contract length, which sets how long the arrangement between the utility and customer is fixed for. The crediting terms; so. these terms define whether compensation is granted as a billed credit or directly as cash payments. And these crediting terms determine the extent to which credit can be carried over between billing cycles and the circumstances under which credits may expire or cash payments are paid to the DG system owner.

There's netting frequency. So, netting frequency is the time period under which DG production and customer electricity consumption are summed and measured for billing purposes if the system owner consumes the DG electricity. We have credit reconciliation period, which is a predetermined time at which a customer's banked kilowatt-hour credits expire. And this really only is valid when the customer is allowed to bank energy credits from one billing period to the next. And finally, PV system caps. So, a system size cap sets the maximum individual system size that can participate under a given compensation scheme.

So, before we look at the three main metering and billing arrangements in more detail I did want to spend a bit more time describing and defining self-consumption and exported generation. So, let's use this graph here to understand both these components. And you'll see this graph is reminiscent of what Alex showed earlier in the introduction to DPV building blocks. So, the blue dotted line represents the customer's gross electricity consumption over a single day. And we see that the customer's peak is sometime in the afternoon in this particular case. The red line represents the DPV generation over the day and peaking at noon. So, we can then overlay the customer's net load, which is shown in this gray line. And I'll now remove the red line to focus on the customer's net load.

So, we see that midday for this customer, the customer's net load is negative. What this means is that the customer is generating more electricity than they're consuming, and this implies that electricity is both being self-consumed and exported to the grid. So, I've now added the green shaded area, which represents the self-consumed electricity, and the yellow striped area, which represents the electricity that's exported to the grid. So, as we'll be seeing in the next slide, utilities can either choose to compensate these two quantities at the same level or at different levels, depending on the metering and billing arrangements.

So, the first metering and billing arrangement I'm going to be discussing is net metering. So, net metering is used in a number of countries, including the US, where it's the most common way of measuring and compensating for distributed PV. It's also among the simpler ways to meter and bill customers with PV. Net metering allows customers to receive kilowatt-hour credits for electricity that's exported to the grid. So, the diagram here helps us understand how net metering works. When the DPV system generates electricity, that electricity is first self-consumed, and when generation is greater than consumption that electricity is then exported to the grid, shown in the striped yellow arrow leaving the home. When the DPV system generates less than the home's consumption or is not generating it at all the customer purchases electricity from the grid at the applicable retail rate, which is represented by this blue arrow on the figure here.

When there is net consumption the bidirectional meter spins forward and when there is net export the bidirectional meter spins backward, effectively providing a kilowatt-hour credit to the consumer. So, net metering can vary across a number of features. So, for example, kilowatt-hour credits can expire at the end of the month or the end of the year, convert into a cash payment for the monthly or annual access, or it can be rolled over to future bill periods indefinitely.

So, as with each of the metering and billing arrangements, net metering has a number of strengths and weaknesses, and each of these should be considered and taken into account when setting up PV programs, depending on the political priorities and maturity of the PV market. Starting with the benefits of net metering, the first is that net metering is relatively simple to understand and implement; it only requires minor changes to existing regulation in large part because it already makes use of the existing retail rate structures. There are no new rates that need to be developed just for distributed solar. And another benefit is that most electricity customers do not need new electricity meters. Many of the analog meters that are installed in many parts of the world support spinning backwards. But of course, this needs to be checked by each individual utility.

Finally, because the economics of solar are more often attractive with net metering, net metering may be an effective policy to promote the growth of the market. Now particularly for countries which do not have much experience in distributed solar, these are all important for both consumers and regulators to develop the PV market. There are a number of challenges or concerns with net metering that should be considered, however. So, the first is for complex rate designs, particularly when there is a demand charge present. For example, it can be difficult to predict bill savings without access to historical hourly load data, which may not be available.

For complex rate designs, particularly—so—sorry, with net metering it also allows the customer to self-consume their DPV generation and effectively compensate PV generation at the energy portion of the retail rate, which is billed per kilowatt-hour. This means that the utility potentially under-recovers its costs if the revenue reduction is higher than the avoided cost from DPV. Also, if rates need to rise to account for that difference between revenue reduction and avoided costs. And this is effectively across subsidy from non-DPV to DPV households, presenting a potential equity issue, given that DPV households tend to be higher income or wealthier. It's important to qualify those expected impacts or various elements described. Simple back-of-the-envelope calculations can give order of magnitude impacts, and at low levels of DPV adoption some of these negative impacts are quite insignificant and in the noise really.

So, the next metering arrangement is Buy all, Sell all. This was quite common in the early 2000s in Europe and other parts of the world, and sometimes people refer to this as a feed-in tariff. Though we're going to avoid that terminology here, _____ feed-in tariff actually encompasses other types of arrangements. Under the Buy all, Sell all mechanism the DPV generation is metered completely independently and there's technically no self-consumption. As we see in the figure, the DG production meter measures the entirety of the PV generation and the consumption meter measures the entirety of the consumption, and all this is unaffected by the PV system. The sell rate has to be defined and there's no direct relation to the customer's electricity rate design. The sell rate is often set in advance and it's constant over a fixed number of years, but the rate could potentially be updated or be dynamic in nature.

So, clearly the Buy all, Sell all arrangement is simple to understand and provides an easily quantifiable value proposition to the customer and cost to the utility. Because the DPV generation is accounted for independently from the customer's consumption and therefore there's no reduction in load, the utility can calculate the cost of DPV compensation, which makes accounting transparent and simple.

Another benefit to the Buy all, Sell all arrangement is that the sell rate or feed-in tariff can be calibrated for new customers, adjusting to PV price levels. However, if the feed-in tariff is set too high or too low this can lead to unsustainable growth, over-stifling of the DPV market. Also, there's no incentive for consumers to self-consume since the DPV generation is metered completely independently, and this could be an issue for some utilities. And finally, an additional meter is going to be needed to measure the DPV generation, and this can be an obstacle, especially for smaller consumers, in terms of cost.

So, the third and final metering and billing arrangement is called net billing. So, in net billing a DP system owner can consume electricity generated by the DG system in real time and export any generation in excess of on-site consumption to the utility grid. So, self-consumption in this case is allowed and all DPV generated exported to the grid is metered and credited at a predetermined sell rate the moment it's injected into the grid. In the figure here we see that the generation from the DG system directly serves the customer's load. If the PV generation is lower than the customer's load at any given point, whether that be at a time of high electricity load or low or zero PV generation then electricity is purchased from the grid as shown with the blue arrows. And it's accounted for with the net electricity consumption meter. When the PV generation is greater than the customer's load at any given point that excess electricity is exported to the grid and measured using the net electricity export meter. So, this is different than net metering because the exported generation is compensated at a rate that's distinct from the retail rate, and it's predetermined and can be fixed over the length of the contract with the utility or it could change over time.

As with the other two billing arrangements, net billing has its pluses or minuses. In order to help minimize impacts on utility earnings or rate levels, utilities can match the sell rate to the avoided costs of the exported PV generation. Also, since the sell rate is often set to a level that is inferior to the retail rate, self-consumption is encouraged to maximize the customer value of DPV generation, and this can be a desired outcome for some utilities. However, since net billing still allows for self-consumption there could be a reduction in earnings, even if the export compensation levels match the avoided costs, similar to how energy efficiency could impact utility earnings or rates to recovered utilities.

And with that I'd like to point you to the report that was published on this very topic. The link is shared here. Feel free to e-mail my colleague, Alexandra Aznar, or myself if you have any questions on that.

So, that concludes this webinar. And do see the other learning webinars in this training series for additional information about distributed photovoltaics. And to that I will turn it back to the hosts and we'll be starting a Q&A session.

Katie

Wonderful. Thank you to both Alexandra and Naïm for those outstanding presentations. As we shift to the question and answer session I just want to remind our attendees to please submit questions using the question pane at any time. Through this we'll also keep up several links throughout for a quick reference that point to where you'll find information on other upcoming webinars and previously held webinars and how to take advantage of the Ask an Expert program.

We've had some great questions from the audience that we'll use the remaining time to answer and discuss. Our first question is can you explain—the attendee wants to know can they use PV in enhancing the power system quality at night after the sun hours.

Naïm

I can answer that. So, no, so in the evening PV itself is not generating electricity, of course, because the sun isn't shining, and therefore it doesn't have any direct interaction with the grid. So, though during the day there could be power quality and voltage regulation that's done through smart inverters, at night really the—because it's not generating any electricity it can't regulate any voltages or provide any grid services on its own.

Katie

Great. Thank you for answering that. Our next question is would you explain exactly what soft costs are.

Alexandra

Sure. This is Alexandra. I can answer that question. So, soft cost is a broad category and it's really representing anything that's not a piece of hardware. And so, these can vary by jurisdiction as well. Some locations will require certain permits, and so the time and costs associated with obtaining those permits, whether they're from the utility or the local jurisdiction, is wrapped up in those soft costs. The soft costs also include things like customer acquisition and installation labor, and so they're kind of what we call, you know, squishier costs than the actual technical components. And they can really vary and there are a lot of approaches to streamlining some of these processes and reducing these soft costs. There's been a lot of work worldwide with streamlining those costs and reducing them.

Katie

Wonderful. Thank you, Alexandra. Our next question is with a Buy all, Sell all compensation arrangement are residents allowed to self-consume if the utility grid is out?

Naïm

Yeah, so I'll answer that question. So, in most cases, no. So, in most cases when the utility grid is out, because in some sense the way the PV system is wired, the PV system is just basically connected to the utility grid and the—so there's no way really to self-consume if the utility grid is out. In many cases, even under net metering or under net billing, that's also the case, actually. So, when the utility grid is out the customer does not have the option to self-consume that electricity, and that's often regulated by the interconnection rules of that particular utility and could post a risk to the customer, depending on kind of some of the power quality and the inverter outputs.

So, in most cases the customer cannot self-consume the electricity regardless of the net—of the billing arrangement. Though there are a few exceptions to that rule, but I would say in most cases they can't.

Katie

Great. Thank you. Our next question is which developing countries are good model examples of DPV?

Alexandra

This is Alexandra—

Naïm

So, that's—go ahead.

Alexandra

Oh, go ahead, Naïm.

Naïm

All right. Yeah, so that's a difficult question to answer because there's so many ways of implementing DPV programs that there's no—it really kind of depends on the objectives of those DPV programs. Is the objective to promote DPV? To achieve some kind of DPV target level? Or is it to make sure that there are no impacts on rates—on others' rates or utility earnings? And depending on what that is exactly, what that kind of objective is, that makes the definition of what is a good DPV program is relatively subjective. There are successful—if you define successful as high deployment numbers, there are a number of countries that have reached higher deployment numbers for DPV, and perhaps Alexandra can add to this list, but, you know, for example, Mexico has a relatively high DPV deployment. There is some DPV deployment in South Africa. Alexandra, do you have other examples where there would be high DPV deployment and obviously resulting from a DPV program that's been set up to at least promote DPV?

Alexandra Sure. One location that we have worked in over the past three years has been in Jamaica. Jamaica is an example, you know, an island nation where distributed PV has a very strong value proposition for customers, so there's been a lot of deployment there, some of which at the beginning was illegally deployed and connected to the grid. So, over time we worked with energy stakeholders there to really make sure that the interconnection processes were in place and that the program was working properly so that the utility and other stakeholders could understand what was connected to the system.

So, that's an example of what I mentioned in the introduction, of how the value proposition of these systems can be quite strong in places, particularly islands where energy costs are high and power quality may be low in some cases. And it's important to get one's house in order so that these systems can be deployed safely. I would concur with Naïm that the definition of success really varies across the world. We've seen some countries recently adopt some very good best practices. And I'll leave you with one example. We've been supporting the government of Colombia as they've been developing distributed generation regulatory framework, which was recently released in March by the regulator in Colombia. And one good practice that we saw in that regulation is that the regulations had a net billing compensation mechanism that will be reviewed once a certain threshold of distributed PV is deployed on the grid. And so, a good practice is studying those thresholds for re-evaluating policies, because these markets change very dynamically over time, adoption can change over time, and so it's important not to set your policy in stone, but to set up appropriate times to reevaluate them and adjust them to the current market conditions. So, that's one example, recent example I'm aware of in Colombia.

Katie Great. Thank you both for following up on that. Our next question is what parties should partake in defining a vision or a goal in the role for DG?

Alexandra I can take a crack at that one. We believe it's important for many different kinds of energy stakeholders to be part of that vision, goals, and role. What we often see is some of those goals adopted by the Ministry of Energy or they can be by legislative mandate, but it is important to get that utility perspective, the perspective of consumer interest groups, because then I think you have a lot more buy-in as you strive to reach those goals. So, we sometimes see it as a single entity, it can be a policy objective of the administration, for example. But we are a big believer in convening different stakeholders to think through that vision and goal and role so that there is that continued buy-in for a DPV program.

Naïm And to that I would just add and highlight the importance of transparency in the proceedings and making kind of the process at least open to the public, especially in the later stages, so that the public is well informed of how decisions were made and what targets are—or what the objectives of the DPV program are.

Katie Great. Thank you both. Our next question is in regards to net billing arrangement. Who bears the cost of the meter? Is it the customer or the utility?

Naïm So, that is going to depend on the specifics of the policy and how that's drawn up. In some cases, it is the utility that is going to be paying for the cost of that meter, in other cases it is the customer. So, it really—and again, when it's a utility sometimes the utility can rate base that. So, what that means is that they can include that in the costs that they will be recovering through rates, and that would imply that everyone is kind of paying for that infrastructure. When it's the customer paying, of course it's an out of pocket, and that really is determined by the exact details that are going to be implemented in that PV program.

Katie Great. Thank you. And to follow up with that, what is the difference among the compensation mechanisms if the customer never exports electricity to the grid?

Naïm So, I'll answer that as well. So, if the customer is never exporting electricity to the grid, so for the net billing and net metering that would make them actually equivalent, right? So, because the only difference between net billing and net metering is the rate at which that electricity exported to the grid is compensated. So, if they're not exporting, they are self-consuming that electricity, under both net metering and net billing. And self-consumed electricity is valued at the customer's underlying retail rate. So, in those two cases those are actually equivalent.

Now for the Buy all, Sell all, necessarily you are exporting to the grid if you are producing PV. You can't self-consume, so that wouldn't be applicable for the Buy all, Sell all.

Katie Thank you, Naïm. Our next question is what is the typical lead time to establish application and/or registration processes for DPV within countries?

Alexandra I would say that we see a lot of variation in this. For example, what we have seen is with that issue of transparency that regulations will require utilities to post exactly how long it would take to go through an interconnection process. And some countries we've seen very ambitious targets of, you know, three to four weeks to go through a process, and then in some cases it's more of a couple months to go through that process. So, it really varies I would say both within the US and around the world, but again, the important thing is transparency and expediency. You're balancing safety, of course, making sure these systems are going to be safe, but you also need to balance that expediency and not draw out these processes to take what we see in some cases to be a year, a year and a half to interconnect to the grid. Because that can incentivize people to do it illegally.

Katie Great. Thank you, Alex. And to follow that up, what are the advantages and disadvantages to different DPV system size caps?

Alexandra Sure. I can provide some insight on that. So, different sized caps do have advantages and disadvantages. One, they're going to kind of put a limit, obviously, to what a customer can deploy. So, in some cases if they're designed to be smaller, then that means there's going to be a lot more self-consumption. Some caps are larger, and again, it just allows for maybe different kinds of business models. If you have a larger system maybe multiple people could be kind of purchasing that energy from that system. The one challenge with size caps that are larger is that sometimes larger systems can produce more technical challenges on the grid. So, they may need to go through different screening processes to make sure that they won't be causing issues on a particular area of the distribution network, whereas smaller systems typically don't have some of those technical issues involved.

Naïm And—

Alexandra Oh, go ahead, Naïm.

Naïm Yeah. Sure. I would just add to that that in some cases instead of system size caps, utilities may cap the capacity on a specific distribution feeder. So, for example, they may cap the capacity—the total PV capacity on a feeder to 15-percent of the peak capacity or peak load on that feeder. So, that sometimes is a cap—and actually that 15-percent is often, in the US at least, a threshold at which a review, kind of a technical and safety review of that feeder is started. And if that review passes then they allow kind of larger systems or more PV on that distribution feeder. So, that's another way to ensure that kind of the technical and safety requirements are met.

Katie Great. Thank you both. Our next question is what is the effect of PV penetration in large scale on the grid?

Naïm I can start answering that. I mean there are many impacts, of course, on the grid. There are both technical and economic impacts, and I'll start talking about the economic impacts of very large penetration of PV on the grid. So, the first is just to say that most countries, even those that have relatively mature PV markets, don't have on an energy basis very high PV penetration in terms—you know, we're not looking at anything like 30, 40, 50-percent; that doesn't exist in the world as of yet. So, we're still talking about sub-20-percent.

That said, even at those levels there are impacts. And one of the economic impacts is that there is so much PV because PV is obviously concentrated during the daytime, at times when the load isn't very high, the net load, so the total consumption minus the PV generation can become very low at times. What this does is that drives prices of electricity down. So, those more expensive generators that are turned on to serve higher loads don't need to be turned on. And so, you're left with just very inexpensive base load generators. And even in some cases those have to ramp down their production, and that leads to very low prices, and even in sometimes negative prices. And negative prices are seen when basically those base load generators, they cannot ramp down or they can't turn off, so some of these nuclear or coal generators may take a long time to turn off, and the cost of turning them off is actually going to be high, so the prices will go negative.

So, they are effectively paying people to consume electricity so that those generators don't have to turn off, and that's a direct result of PV. And this will often happen in the springtime, when loads aren't that high, but PV generation is high. This has impacts for other generators, right? So, generators that may have been counting on generating electricity during those times to remain profitable may not be profitable anymore. And so, there are definitely impacts to the generation mix and to electricity prices more generally. Over time average costs of generation will then kind of go back up as the generation mix adapts to those PV. And so, for example, those inflexible base load plants that basically can't turn off or are very slow to turn off will adapt or will go offline, and so we won't be seeing the negative prices eventually. But in the medium term that's definitely what happens. And even in the longer term the price profile, so the temporal price profiles of the cost of generation does change and is very much impacted by PV. So, that's part of the economic impact from PV.

Alexandra

Yeah. And I'll just add on the technical side we do see utilities and distribution engineers in particular concerned of a few problems with too much distributed PV on the grid. And Naïm referred to some of these, such as voltage control and power quality issues. But we think there are ways that DPV installations can be "good grid citizens" and they can provide voltage infrequency support, voltage ride-through, they can be arranged so that there is no unintentional _____, they can provide power quality. And so, there are a variety of different mitigation strategies that can be applied to make sure these systems kind of place nice on the grid. And these can be low-cost, including advanced inverters, to, you know, more higher cost strategies such as adding battery energy storage. So, there are a variety of tools that can be used to support the integration of distributed PV on the distribution network and assuage some of those fears of distribution utilities.

Katie

Great. Thank you both for that informative question and answer session. For any questions, we got a lot of great questions from the audience. For any of them that we didn't get to today, we'll connect with those attendees offline after the webinar.

I just want to say thank you again to both Alexandra and Naïm. And I just want to remind everyone that we will be having part two of this series on Wednesday, May 23rd, Building Blocks for Distributed PV Deployment Part 2: the Interconnection and Public Policy. Again, that's Wednesday, May 23rd. So, we'd welcome you to join us then.

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

I invite you to check out the Solutions Center website if you would like to view the slides and listen to the recording of today's presentation, as well as previously held webinars. Additionally, you'll find information about upcoming webinars, like the one on May 23rd and other training events. We're now posting the webinar recordings to the Solutions Center YouTube channel. Please allow about a week for the audio to be posted.

Finally, I'd like to kindly ask you to take a moment and 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.