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Basic Auction Design for Low-cost Renewable Energy Procurement

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Webinar Panelists

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David Jacobs Hello everyone around the world. This is another session of the International Solar Alliance Expert Training Course. I am Dr. David Jacobs speaking here from Berlin, Germany.

This session—Session 10—will deal with auction design—renewable energy auctions—and, in particular, we will talk about basic auction design in order to procure low-cost renewable electricity—solar electricity.

As you probably already know, this training course is a cooperation between the International Solar Alliance—ISA—and the Clean Energy Solutions Center, which is providing assistance for countries with clean energy policies around the world.

I am David Jacobs, founder and director of the consulting firm IET—International Energy Transition—with more than a decade of experience in designing renewable energy policies in many, many countries around the world. So, I'm very pleased to be here with you today to discuss this exciting topic.

This is part of our Module 2, where we discuss policies for large-scale solar PV deployment. As you might have checked out already the entire training course, you see that there's two very interesting and related training units—in particular Session Two, which is for the beginners. If you haven't dealt a lot with renewable energy policies before, you can get an introduction to solar policies, including net metering, net billing, NET-FIT, feed-in tariffs, and, of course, also auctions. And what is probably even more interesting for you is training session 11, where we'll discuss some more advanced auction design. We see a lot of countries which are now adjusting their auction design.

They're no longer just looking for least-cost procurement, driving down costs more and more, because already today, solar PV is outcompeting most other power generation technologies. So, instead, policy makers are now looking at procuring high-value solar PV, also giving some occasional incentives at integrating objectives related to other socioeconomic benefits. So, check out Session 11 if you're interested in that.

Just an overview of what is going to happen in the next hour. We will have, first of all, a discussion of the learning objectives really quickly, then, move on to the basic auction design or the basic policy design for procuring low-cost renewables, low-cost solar PV, and we'll also have an outlook to Session 11, which I already mentioned before. You will get a lot of further reading. There has been many, many, many reports that have been published in the last five-six years. And, as always, you will have a knowledge check—a simple knowledge check—in the end, so, you can test yourself and see whether you've actually understood the basic information communicated during this webinar.

So, looking at the learning objectives. We're going to learn about the recent solar PV auctions and their results around the world. Please, keep in mind that this webinar is recorded in 2019, so, if you listen to it in 2021, things might have changed, 'cause we're living in a rapidly developing solar PV world. We will also try to understand the factors behind these recent results, which factors have been paramount in driving down costs for solar PV. We will learn about general framework conditions for low-cost renewable energy procurement, which also applies to other technologies in solar PV. And last, but not least, we will discuss each of the basic auction design elements for low-cost procurement.

Looking at renewable energy auctions, solar PV auctions around the world, we see that renewable energy auctions have been implemented in many countries in the last 5 to 10 years. Looking back at 2004, we only had 8 jurisdictions around the world that really made use of auctions for renewable energy procurement. This number has now increased considerably in 2016, based on this graph from IRENA. Already 73 countries around the world used auctions for procuring large-scale solar PV projects, large-scale renewable energy projects. This graph actually compares the diffusion of auctions with the diffusion of feed-in tariffs.

Feed-in tariffs have been around for much longer. Already starting, well, with the first feed-in tariff in 1978 was the PURPA Act in the United States, and a lot of feed-in tariffs being implemented in the 1980s—1990s in Europe, and then, spreading around the world in the 2000s. So, from 73 countries using feed-in tariffs in 2004, the number has actually increased to 86 countries in 2016, and I think close to 100 now in 2018-2019. So, this alone shows you that both support mechanisms are in use and actually, they're not mutually exclusive. This is something we're going to discuss in detail in Session 11.

You can actually combine them—and a lot of countries actually do combine them for different technologies, for different market segments. So, there will be some more details on this in the next session.

So, let's now take a look at the recent auction results for solar PV over the last couple of years.

In 2016-2017, we saw some very low prices being procured by solar PV, which also caught a lot of media attention. So, when I talk to policy makers, I always tell them, "Don't only read the headlines; also do an analysis of the auctions which are not communicated widely in media." And this is also what we're going to do in a couple of minutes. But, let's first take a look at these auctions in March 2016. Mexico was able to procure renewable energy solar PV for $0.03.2 per kilowatt hour with a 15 years power purchase agreement.

A couple of months later, Chile was even reaching lower prices with $0.09 per kilowatt hour. And then, also, in the United Arab Emirates and in Saudi Arabia in 2017, we saw even lower prices with $0.02.4 per kilowatt hour—even below $0.02 per kilowatt hour being procured in Saudi Arabia with a 25-year power purchase agreement.

Interestingly, we see slightly higher results in other countries. Here, just an example from Germany, which, of course, has less good solar radiation than some of the countries discussed before. I included Germany in this list primarily because this is a good example to show that prices do not necessarily have to go down all the time. We saw a procurement of 201 megawatt in April 2017 at around $0.05.3 per kilowatt hour and then, a year later, another 200 megawatt were procured, but then, prices actually went up, and the major reason for this was restricted availability of land. A lot of the agricultural land, which was still available in the first auctions, was no longer legible under the new procurement design, therefore, prices actually went up. In Brazil, it was actually more the contrary and we saw, as expected, prices going down from one auction round to the next.

What is especially interesting is that we now also see very low-cost solar PV procurement in many developing countries and even so-called least developed countries. The World Bank has been able to establish a very successful program called Scaling Solar, which includes one-stop-shop streamlining for solar PV projects and also a lot of de-risking elements. For instance, in Zambia, under the scaling solar project, a 50-megawatt solar PV was procured at about $0.06 US per kilowatt hour under at 25 years power purchase agreement. In Senegal, in 2018, prices were even lower—around four Euro cents per kilowatt hour for a 60-megawatt project. So, this just to show you that if you get the basic framework conditions right, if you introduce some de-risking elements in your policy design that help you to drive down capital cost, then, you can procure solar PV quite cheaply—cheaper than any other power generation technologies, probably—in your country.

Here's another interesting graph which shows some of the average prices resulting from auctions for solar PV and onshore wind energy between 2010 and 2016. And, as you can see quite clearly here, prices more and more converging. Actually, in one of the latest auctions—technology-neutral auctions where different renewable energy technologies and also conventional power generation technologies were competing with each other,

we saw that solar PV, in many countries, were actually out-beating all of the other technologies and all of the bids just went to different solar PV project developers. And I firmly believe that this trend will continue. So, even though these technology-neutral auctions somehow being hyped in the last couple of years—because there seems to be a trend of convergence of prices—I think that solar PV will probably out-compete a lot of the technologies in a couple of years from now, and then, policy makers will probably reconsider whether purely technology-neutral auctions will still be the way forward or within that also, other elements which help to integrate different technologies into the power generation mix.

Might not be easy to procure with technology specific auctions, but this is something we're going to discuss further in the second session on auction design in Session 11.

Here are just a few preliminary remarks on how to—why we see such important price decreases in solar PV. One aspect I want to mention at the start of the year 2019 is the fact that we see—currently see some over capacities in the PV manufacturing market, mostly due to the fact that the Chinese government has announced to reduce the procurement of solar PV in the next couple of years, and therefore, we have some over capacities in the Chinese market, which, of course, also affects other markets, because a lot of Chinese products now need to be pushed into other markets, which will probably lead to further price decreases of modules of PV inverters and of other components. And secondly, I wanted to mention that when you read the news about solar PV auction results, you have to keep in mind that these are not current prices, but these are more projections or estimates of future prices. Because when I—as country A launched an auction this year in April 2019, then, I will not require the PV system to be ready in May 2019, but I'll probably give the PV project developer a year or maybe even two years to develop the project. And the project developer will have an intrinsic motivation to delay the procurement of the PV modules of the inverters, of all other components to a very late stage of this phase, because they are normally assuming that prices of solar PV modules and other components will go down in the future.

So, when you actually see some of the auction results in the media, please, always keep in mind that these are not current prices, but these are actually expectations of project developers to how cheaply they can build and procure solar PV in a couple of years from now.

When you only read the headlines—this is what I mentioned at the start—you should tell policy makers, when you talk to them, "Hey, this is only the results that you read in the headlines about Saudi Arabia, about Chile. There's also some auctions which get less media attentions, but which are also relevant." For instance, in January—this year, January 2019, there was an auction for solar PV in Japan which came up with significantly higher prices—$0.13.6 per kilowatt hour. And the major reason for this was some constraints concerning lend availability, grid constraints, and also, of course, higher labor costs than in many developing countries. So, this auction was

actually undersubscribed, so, there was less competition, and there was less bids received than actually the government wants to procure.

So, all of this taken together led to this significantly high prices for auctions of solar PV. Similarly, but different case from India with Gujarat, also January 2019, that solar PV auction was actually canceled due to the high prices. So, policy makers in Gujarat were hoping to achieve similarly low prices as we have seen them in other provinces in India, however, this didn't happen for several reasons. And then, the government decided to simply cancel the auction because it didn't like the results. So, this also sometimes happened, and you don't read too much about this in the media because the projects would never be realized.

Nonetheless, it is interesting to keep track of the cost development of different components of solar PV. IRENA—the International Renewable Energy Alliance—is doing a good job on this. They have a department which is tracking prices for different renewable energy power technologies. You can actually find the link to some of the material here. The IRENA Cost Report—this is some data from the 2018 report depicting prices from early 2017-2016.

So, when you look, for instance, at prices in India and Germany for large-scale solar PV, they are probably half as low already two years later. So, these are average numbers, but when you really look at the most cost competitive companies, they can probably build you a large-scale solar PV system with an installed cost of $500.00-$550.00 US per kilowatt installed, not the prices that you see here. But it's just interesting to see that you see some quite significantly differences—especially when you look at the Japanese and their US market compared to other markets around the world—which is, of course, due to level of competition, but also to other factors which we will still discuss later.

So, what kind of framework conditions to we actually need? What kind of de-risking elements need to be part of your policy? There has been quite a lot of research on this as well in the last couple of years.

We tried to summarize some of the key findings in a short report which we wrote for a global energy vendor last year called Low-Cost Renewables where we tried to identify 15 key factors that actually help policy makers to drive down the cost of renewables. And, as you can see from this pyramid here, most policy makers probably still think that the price discovery mechanisms—the type of support mechanism—is the most important choice they make whether they go for a feed-in tariff or an auction. We actually argue that this is one of the least important parameters when it comes to low-cost procurement—that other factors are much more important. You can really influence the resource and technology factors. You can't really influence how much sun you have in your country.

You cannot really influence—well, only to a very limited extent—the cost of solar PV technologies. What you can really influence are these three factors in the middle—"contractual", "regulatory" and "market" factors—we have termed them.

And I just wanted to take some time to walk you through some of these factors so that you get a better sense of what enabling environment you actually need to procure solar PV at lowest cost. Let's look at some of the market factors first. First of all, the market size is, of course, very important. Is your renewable solar PV market big enough to actually create economies of scale and to enhance competition? For instance, I had a policy maker from a relatively small country contacting me recently and they said they want to procure 20 megawatt of solar PV.

They want to run—they were thinking that by running auctions, they could decrease prices, whether this would be worth it, and I told them that probably with only 20 megawatt of procurement over the next 5 years, you would not be able to attract enough interest from international project developers to come to your country and therefore, maybe operating with other support mechanisms—like feed-in tariffs—would be a wiser decisions. Whereas, when you're in a country like China or like South Africa and you say, "We're going to procure several gigawatts of solar PV every year for the next five year" this certainly enables you to attract the interest of international project developers and create competition and economies of scale. Project size is also very important. Of course, we see, quite considerably, price decreases for very large-scale projects like the ones we discussed earlier in the United Arab Emirates and Saudi Arabia where we saw mutli-hundred-megawatt projects—or even gigawatt projects—which will help you to reach these very low-cost prices. One of the most important factors is, of course, the cost of capital.

So, do you have a stable political and regulatory environment also helping you to drive down interest rates? The presence of qualified workforce is also very important. Do you need to import labor, or do you actually have them available within your country? Do you have minimum wages, et cetera? So, remember the Japanese example already showed us that higher labor costs can, of course, drive down your renewable energy solar PV procurement costs.

And, in many developing countries, the presence of supporting infrastructure—like roads in order to get the modules from the harbor to the site—is very important because we've seen, in many countries, that transporting the equipment over the last, well, let's say 20 to 50 kilometers to the site can be just as expensive as transporting the modules several thousand kilometers over sea to the existing harbor. So, depending on this key infrastructure, prices may also vary quite considerably.

Then, we identified some regulatory factors. As I mentioned before, a stable regulatory environment is, of course, crucial. What is also important is streamlined permitting and administrative procedures. Some research has shown that prices can be further decreased by 5 to 10 percent by putting these streamline permitting and administrative procedures in place. Land access and the cost of land is also very crucial for your permitting procedures, but also the fact whether there is a lot of land available or whether there's limited land available and a lot of speculation on land, which further increases prices, can also be a very determinant factor.

Cost—grid interconnection procedures—is very important. Do you have a shallow _____ grid connection charging approach where the project developer only pays the connection line to the next existing connection point or do you have more of the deep connection charging approach where the project developer would also need to pay for upgrades of the existing transmission grid? These factors are, of course, also very crucial, as well as other factors such as environmental and social impact assessments—how complex are they? How lengthy are they? Import tax on the equipment, et cetera.

Thirdly, let's look at some of the contractual factors. We call them "contractual factors" because they're normally part of the power purchase agreements or the design of the power purchase agreement. What is very crucial is a solvent a reliable off-taker. So, depending on the credit rating of your utility, you either already have a solvent and reliable off-taker or you don't in countries where utility—which in single-buyer market would usually be the off-taker in countries where this was the case if they had a very bad credit rating. Government sometimes even try to establish an independent off-taker who would hopefully get a better credit rating because they would get also maybe some government guarantees.

And with these in place, you can further increase capital cost. The contract duration—I mentioned this already at the start—is also very important. All of the very low-cost procurement of solar PV that we've seen in the examples before had power purchase agreements ranging from 15 to 25 years. So, this is, of course, very crucial. Just as well as a payment structure referring to how will you actually receive the payment—in 95 percent of all cases, we're talking about payments per kilowatt hour—normally fixed prices per kilowatt hour.

Sometimes, we also see combination of prices paid per kilowatt hour and prices paid for firmly available capacity, even though this is less applicable for solar PV. And in many of the European countries, we now also see premiums which are paid on top of the existing wholesale market price. An import aspect as well is inflation indexation. So, when you see the result of an auction that has been published, one of the first questions you should ask—"Are these prices indexed to inflation?" Because this, over a 25 years period, of course, will increase the total revenues received by the project developers quite considerably.

Or, "Are prices nominal values and are not indexed to inflation at all and will stay stable over the 25 or 20 year period?" Currency risk mitigation is also quite important—especially in countries where you have a lot of currency fluctuations. So, in some countries, you see currency risk mitigation by simply issuing contracts in international currencies like the Euro or the United States dollars. And last, but not least, dispatch and curtailment risks become more and more important because in more and more countries, we see constraints in the transmission and distribution grids which will then lead to curtailment of renewables. So, it is very important these days to have clear rules of how curtailment will be compensated—whether the project developer

will be 100 percent compensated for any curtailment which is not related to the performance of his power plant, but not his system-related problems, or whether it will be a fraction of the normal power purchase agreement price that was agreed upon earlier—let's say, 90 percent.

So, this was just a general introduction for important factors that help you to drive down the cost of solar PV, 'cause a lot of the discussion that we see in many jurisdictions—whether they should go for auctions of feed-in tariffs—is sometimes mislead because other factors are much more crucial for bringing down the prices. So, let's look now at some basic design features of renewable energy auctions.

And I've structured them into six different questions. So, first of all, what is being auctioned? How much and when? So, the procurement schedule, what payment will the winner receive? The payment modalities.

What mechanism is used for price determination? The price finding mechanism within auctions. How can I ensure that the projects will actually get built? We're talking here about the penalties for non-compliance. A very important question is also eligibility.

Who can participate in the auctions? Which is normally linked to some prequalifications that project developers need to put on the table before they actually even start participating in an auction. And, in the second step, the question would be—on what basis are bids evaluated? So, what is the selection criteria? Is this price only? Or do you also have some additional selection criterias implemented?

So, let's start with the procurement schedule.

So, what will be procured, when, and in what frequency? So, the scale of the auction is, of course, very important and this also depends on how much renewable energies you want to procure in the long-term. So, in the best case, of course, you develop some integrated resource planning for the next 20-30-40 or even 50 years where you also set out specific quotas for different technologies depending on what you need and how much it should cost, and then, you can really determine the scale of the auctions—how much you will procure. You can also say how many times a year you want to run an auction and are there upper or lower limits on the project size. This is very important because when you only run one auction and you don't give investors or project developers an idea of how this market will develop in the future, it is likely that you will not attract sufficient amount of competition within your market because, as I mentioned before, when you only run an auction for 30 megawatt of solar PV, this will probably not be enough of an incentive for an international project developing company to set up an office in your country to become familiar with the policy design, with the auction design, and to participate.

Instead, it makes much more sense to say, "Hey, we want to move into this direction with our power sector since most countries are now de-carbonizing their power sector renewables. We'll play a crucial role in this." So, you can

say, "Hey, we're going to run an auction 2 times a year for the next 10 years. We're going to have total procurement of X gigawatt in annual trenches for solar PV auctions will be 200 megawatt." Which will, of course, be more attractive.

You also need to decide whether this auction should be technology-neutral or technology-specific. Of course, there's various advantages and disadvantages for this. The most important advantage of the technology-neutral auction is, of course, more competition and hopefully, also lower prices, because you will primarily procure technologies—or the technology—with the lowest prices. However, as I mentioned earlier, in order to come up with an optimal system design, you might also want to have some technology-specific targets, because, for instance, a good combination of wind energy and solar PV or solar PV and other fossil fuel based power generation technologies might be more important than simply just procuring these cost technologies all the time. So, this just, very quickly on the procurement schedule.

Let's now look at the payment modalities—what payment will the winner receive?

Here, we primarily have two different types of payment modalities. One is called "pay-as-bid" and the other one is marginal cost payment. And in order to understand them, it's good to look at a graph.

Here, you see in this graph, the volume that a certain government wants to auction or wants to procure. This is the auction volume—here, indicated with the red lines. And then, you see the different bids coming in indicated in the blue and green squares. So, what you do is as the procurer of renewable energies is you select all the different bids from the different project developers and then, you put them in a row—in a sort of merit order—and you start with the lowest and then, you line them up. And then you see which projects you actually need, how many projects you actually need, in order to reach the auction volume that you wanted to procure in the first place.

So, this also shows you then the difference between pay-as-bid and marginal cost payments. So, pay-as-bid would mean that everyone gets exactly the price that he or she bid. So, in this case, let's look at this green bar. Per project developer, the solar PV project developer would get exactly the price PX—which you see indicated in the X column, whereas, when you go for marginal cost payment, you would say—we'd look at the last solar PV project that we actually need to reach out target and this large last project will determine the price that all project developers below this will receive. There's some discussion amongst economists—which of them is better.

Some say—well, intuitively, you would say, "Well, pay-as-bid is probably better because, in this case, I will only pay this green guy what you receive here, and I won't pay him everything above." However, there's also some economists that say, "Even under a pay-as-bid system, project developers were not necessarily this close—the wield cost of the project, but they will always be strategic bidding, so, there will always be an assumption on what will be the highest possible bid I can make to still be part of the winners."

So, it is nowhere assured that this green project developer here—that he's actually disclosing his wield cost. Maybe his costs are lower, but what he's actually disclosing is his expectation of the outcome of this bidding round and he's assuming that with this bid that he's putting forward, he will still be part of it. However, despite all of this economic argument for or against marginal cost rising and pay-as-bid, we see that—I would say 90 percent of all countries actually use pay-as-bad because those seem to be much more intuitive for policy makers and there's also much more—much easier to communicate to the public that you only pay each project developer the price that they actually need or that they suggest that they need in order to realize a project.

So, to cut a long story short, most countries use pay-as-bid as a payment modality.

Another question is for how long will you receive the payment—the contract length?

I mentioned this before—that in most countries, their very low-cost procurement of solar PV was realized with relatively long payment periods, relatively long PPAs. When you look at PPA design for renewables, most countries currently opt for a 20-year period for all renewable energy technologies because this is somehow in line or it reflects the economic lifetime of many of the renewable energy technologies. Some countries have now opted for large—even longer time frames for solar PV because we already know today that solar PV modules that have been installed in the 1980s-1990s are still operating, so, even though there is, of course, some degradation of the output of the module, they can quite easily run for 25-30 years. So, what you then need to do is to strike a balance between, well, the longer economic lifetime of solar PV, but then, also, the ability of the finance sector to provide loans. This is a frequent problem you see in developing countries, especially in emerging markets.

Many banks are not willing to provide loans for longer than 10 years and this, of course, should be taken into consideration when you design your solar PV policy—that you first of all, look at what is the finance sector actually able to finance. And if it's only 10 years, then you—10 years of financed, with a little bit of depth there, then, you might want to opt for power purchase agreements of only 15 years.

This is an interesting graph which shows the capital expenditure and the operation expenditures for different technologies. You actually don't see the technologies here. Here, on the very right-hand side, you see solar PV. So, you see that for solar PV, 95 percent of your total project cost are CAPX, whereas only 5 percent is actually needed for operational maintenance of the systems for cleaning the modules from time to time, et cetera. Whereas this is, of course, much different when you look at a gas-fired power plant here on the very left, _____ gas powered power plant—here, you have a very limited CAPX—capital expenditure at the start of the project for buy-in with the gas plant, and then, relatively high cost for purchasing the gas and for operating the gas turbines.

So, keeping this in mind, this is very important for policy makers to understand when you discuss the lengths of power purchase agreements with them, because when you have a technology like solar PV where most of the costs are fixed, most of the costs are capital costs and they need to be covered up front, then, of course, it makes much more sense for you to have long-term power purchase agreements which also give investors much more security.

Maybe just one more word on the length. It is, of course, makes more sense to have longer power purchase agreements because this will also reduce the LCOE and the payment per kilowatt hour that you'll have to pay. However, a 10-year contract does not have twice as high prices as a 20-year contract, which you also have to keep in mind. And the underlying reason for this is that the near-term cash flow is valued much more highly than cash flow in the distant future, therefore, you're not going to reduce the payment per kilowatt hour from $0.10 to $0.05 by expanding the contract length from 10 years to 20 years. So, you have to do some sensitivity analysis on the impact that a longer-term power purchase agreement actually has on your power purchase price.

Some countries also opt for front-loaded payments that you actually receive higher payments per kilowatt hour during the first years of operation and then, it drops down to a significantly lower price. Either you determine this as a ratio of certain years—for instance, you get a higher price for the first 10 years and then it goes down for the next 10 years. Some countries have also said, "No. We actually determine this as a function of full load hours." This has especially been used in the case of wind energy; not so much in the case of solar PV.

They're saying, "Okay. You get payments for the first 15,000 full load hours at a relatively high price. This will assure that with this payment, you will actually recover most of your CAPX, and then, we will reduce the price significantly and then, the tariff you get for the remaining hours of operation the next 10,000 full load hours, for instance, you will only get a price which will allow you to cover your relatively low operation maintenance cost of your project."

The price-finding mechanism. Let's look at this one. What mechanism is used for price determination?

Here, we have also, again, two different types of auctions. We have sealed-bid auctions and descending clock options—also called "Dutch auctions". The sealed-bid auctions are used, also, again, I would say, in 90-95 percent of all countries that use auctions where you—well, as the name already suggests, it is more like you put a certain price on a piece of paper, put it in an envelope, send it off, and then, the prices will be compared one by one. Of course, it is a bit more complicated than this simplistic image, but this is, more or less, how it works—that you have no more ability, in the end, to adjust your price, which is actually the case in a descending clock option—or Dutch auction.

I will try to indicate this here with this graph. So, the government actually starts by creating an auction and calling out for procurements at an initial price. And then, you have project developers that come forward and then say, "Hey, I would like to be part of this at this price that you're setting." And then, the government is actually reducing the prices further and further until they reach the point of the amount of gigawatt hours, in this case, that they actually wanted to procure. So, you have here, four different stages of this descending clock auction starting with one price, and then, prices being reduced further and further until the optimal price is evaluated or allocated by reducing the price and having the optimal amount of renewables that needs to be procured.

So, you have multi-round bids if the auction starts with high prices and then calls successively lower prices until the quantity offered is reached.

But, as I said before—also, in this case—sealed-bid auctions are probably the default options for many policy makers around the world. What is more interesting are penalties for non-compliance, because we saw in some of the earlier auctions—for instance, in France in the 1990s, also in the United Kingdom with the non-fossil fuel obligations in the 1990s-2000s—that policy makers received a lot of very low bids, but then, they realized that the projects were actually not being built in the end. So, an important design element which was integrated in recent auctions were these penalties for non-compliance.

So, how can you penalize someone if he fails to fulfill the awarded contract? You can, for instance, not pay back bid bonds or construction bonds or completion bonds. We still going to discuss this a little bit further when we look at the material and financial prequalifications in a couple of minutes from now. So, a bid bond, in essence, is a certain amount of money that you have to give into an account at the bank—let's say $5.00 per kilowatt installed. And in the case that you do not realize a project, you're not going to get the money back, but instead, this money goes to a government agency and they do whatever they want with it.

So, it's a pretty heavy financial penalization for you if you participate in an auction, you'll win the auction, and then, you don't fulfill your contract obligation by building with your solar PV plant. Some countries have also opted to reduce the payment levels or the payment periods. So, let's say you participated in a solar PV auction, you received a payment of $0.05 per kilowatt hour, then, you're not realizing your project on time—maybe a year later—and then, the government says, "Hey, we're going to reduce the payment now from $0.05 per kilowatt hour down to $0.04 per kilowatt hour" which, in theory, is a feasible approach. But what happened in many cases was that these projects got bankrupt because they would no longer receive the money that they actually needed to fulfill their financial payment obligations and this, of course, would then further endanger the operation—the proper operation and maintenance of the system. So, this sometimes had some negative side effects.

Therefore, some policy makers sometimes also decided to just exclude these project developers from the next auction round, which is, of course, can be a very significant penalty in the case that you are in country where you set up an office, you want to participate in the auctions for the next five years, and then, you're no longer able to participate in, let's say, the next two or three auction rounds. So, that non-financial—or not so direct financial—penalty might also work quite well. As mentioned earlier, what you should definitely do is define lead times for different stages of the project.

Defining maximum lead times is very important to avoid also speculation and to be assured that projects will get built in time. As mentioned before, for a solar PV project, lead times are much shorter than other renewable energy power generation technologies and in more mature markets, we're looking at lead times of 6 to 12 months; in less mature markets, maybe 1 to 2 years. So, you can actually define maximum lead times also for different project phases such as grid connection, start of power generation—even procurement of important components—so that you really keep track that the project is being completed in time.

What is, then, the penultimate very important design feature are the prequalifications—who can participate in auctions? Who cannot?

So, we are primarily talking about two types of prequalifications—that is material prequalifications or financial prequalifications. So, that means that if I want to participate in an auction, the government or the policy maker actually tells me what I need to have, what I need to show before I can actually even participate in this auction. And there's some people that say, "Purely, financial prequalifications are enough." Others say, "No. You actually need some material prequalifications such as securitization of the land that you want to build a solar PV project on in order to avoid some speculation."

So, important material prequalifications are grid access and interconnection so that you already went either to the utility or to the transmission grid operator and asked them whether—in the region you want to build the solar PV project—sufficient grid capacity is actually available and that you already assure that you get the connection. As mentioned before, securing the land is very important—that you will not necessarily have to buy it yet, but you need to show that you have the option of buying the land, of leasing the land. Some cases, there's even the requirement of having some pre-contracts for purchasing equipment, even though this is less common that you, for instance, need to show that you will be able to purchase your solar PV modules from a certain equipment manufacturer. Or other permits. For instance, we saw, in some of the early auctions in South Africa, that you needed to show an environmental impact assessment in the location where you wanted to build your solar PV or wind park and this needed to be part of the material prequalifications you needed to show at the start, before even participating in the auction.

Financial prequalifications usually include bid bonds—a few more explanations on this in the next slides. Some also say that you need to

demonstrate certain financial strengths—that your company needs to have XXX turnover per year or that you need to have certain other indicators that are used to see whether your company—or the company of the project developer—is actually big enough to develop this project. And some even say that you need to have already project that finance—some solar PV project so that you need to show that you have already developed, let's say, in solar PV projects around the world. Which is, of course, easy for international project developers, but this can be quite a barrier for national project developers in emerging markets. So, I would be rather careful with these types of financial prequalifications.

Let's take a closer look at the bid bonds now. What are the reasons for bid bonds? So, as mentioned earlier, developers need to put down a certain amount of money in order to participate in the first bidding round, and the money will be lost if the project is not executed as promised or if it's not realized in time. And this has been a very important design feature to ensure that only very serious bidders will participate and that you will avoid some excessive competition which will further reduce prices that you receive, but with the bids, but would also lead to a situation where projects, in the end, will not be realized. Designing these bid bonds is a bit challenging because they, of course, include quite high transaction costs, and you also need to have a certain, well, financial strength in order to be able to pay them.

So, it might lead to a situation that small-scale actors or emerging national actors in developing countries might be excluded from the auction right from the start. This is also why some countries have opted for lower bid bonds for some small-scale actors such as community-owned solar projects and so on. Let's take a closer look at some of the bid bond design.

How do you structure them? They're normally structured as a payment per kilowatt hour installed. So, you're bidding a 200-megawatt project and then, you need to pay $5.00 US, for instance—$5.00 to $10.00 US—per kilowatt that you're bidding. As a bid bond, sometimes it's also defined as a percentage of the total estimated project costs—5 to 10 percent, normally, in the case of solar PV. Some policy makers have also said, "Hey, if you're already at a really relatively late stage of your project development—you've already maybe built the project, it's already standing there, you just want to participate in the auction—then, you might have to pay a reduced bid bond, because we already know that you've come a long way with developing this project."

There's also different types of projects. There is construction bonds, as I mentioned earlier, which you would have to pay after signing the contract and during the construction. Or there are also called "completion bonds". So, after signing the contract and before completing it, you need to pay this money and you only get it back after you have completed it and started producing power. When do you get the money back from the bonds?

Normally, when—well, in the case of construction bonds, when the PPA is signed—or sometimes, when the power is produced—some policy makers make it a little bit more complex and they start paying back your bid bonds in

case construction bonds and completion bonds are combined into one—that you get some of the money back already after achieving certain milestones of the project. But this is normally not the case. Normally, it's just bonded into one type of bid bond and you get it back after the PPA is signed or after you actually start producing the power.

Now, let's take a closer look at what we will discuss in depth in Session 11—and these are assessment criteria. So, in contrast to the prequalification criteria which we just discussed before, we're not talking about something that you necessarily need to have in order to participate, but the assessment criteria are more about what policy makers would like to see in the proposals that you're receiving, and then, they can rank your bids either low or higher. So, what this actually means is some governments say, "We only look at the price that you're proposing." So, these are priced only as assessment criteria. But in more and more jurisdictions around the world, you actually see a combination of prices that are offered and other parameters, other indicators that are in line with other policy objectives.

And these are the two major types of categories. So, first of all, socioeconomic benefits, which will normally include local content requirements—also, maybe requirements for certain job creation or even the ownership and the actor diversity is sometimes incentivized via auction design—that, for instance, national actors receive a certain preference, especially in emerging markets where you don't yet have a national industry but you would like to build one maybe. And what we see more and more in countries with high shares of solar PV and also other renewable energy technologies is some locational steering and some incentives for optimal system integration. Because, as you want to integrate increasing shares of renewables into your system, increasing shares of solar PV, the location of your power plant becomes more and more important. So, sometimes, there's technical specifications for system integration and sometimes there's locational steering such as either the pre-development of sites, some development zones for renewable energy, some incentives and disincentives, or other mechanisms which we will discuss further in session two.

So, keep in mind that the selection criteria can either be only price—so, you would only look at the price that is offered in the auctions—or, they can be a combination of price—let's say 70 percent go just for the price, and then, you have 30 percent which are actually assessed based on other impact criteria—either socioeconomic or locational or related to system integration.

So, this is actually an interesting discussion. What should you put into the prequalifications and what should you put into the assessment criteria?

The more that you put into the prequalifications, the less competition you will have. Because by having very stringent, very strict prequalification criteria, you're excluding more and more project developers from participating in the bid because maybe, well, they do not have the financial strength, they do not have this and that permit yet. So, there's some analysts that say, "Hey, put as little of the requirement as possible into the prequalifications and rather, put it into the assessment criteria." So, this is a really—one of the more difficult

balances you have to make between the prequalifications and the assessment criteria. Here, just a general comment.

When you have very lower material prequalifications, then you need relatively high bid bonds or relatively high financial prequalifications. However, if you have no material prequalifications, this might also lead to some speculation and therefore, you need some strict lead times that assure that the project will be put in place on time and that not, for instance, due to a lack of material prequalifications such as securitization of land, it will take the project developers five years to actually buy a good piece of land to realize it. So, by having very strict lead times, you can actually balance this. So, what it comes down to in the end is a rather complex interaction of these six basic design features of renewable energy auctions which were just discussed before. So, really, depending on the policy objectives you have in your country, you need to balance the prequalifications—material, financial—with the assessment criteria, with your very specific policy objectives within your country.

So, just to summarize the advantages and disadvantages of renewable energy auctions for solar PV compared to other support mechanisms.

The advantages are, of course, that they're rather cost efficient because you have price competition amongst project developers. At the same time, they offer a relatively high investor security because they will also normally result in long-term power purchase agreement. So, what you see is normally a higher risk during the project development phase because you're still not sure whether you win the project, but once you're awarded the power purchase agreement—your 20 year contract or 25 year contract—you actually have a similar high investor security as under a feed-in tariff. What it also allows to you—at least theoretically—is some volume and budget control, because you can actually predict how the renewable energy sector will evolve, how much renewables were procured from one year to the next. If, of course, you manage to avoid non-compliance with your procurement targets, you need to have these very strict penalties for non-compliance.

And, as I mentioned before, they can also be combined quite easily with other policy objectives such as local content. So, this is also why many countries have opted for the support mechanisms—because it allows them to also pursue other socioeconomic development objectives. Some of the disadvantages—there are relatively high administrative costs compared, for instance, with a feed-in tariff, because, well, from a government site, you need to develop normally a special unit within the ministry or within a different agency which is dealing with all the auctions, which is dealing with the assessment of the auctions, which is dealing with the preparation of the bid documents, et cetera, et cetera. So, this is already quite complex from the government perspective, but it is also relatively complex from the project developer's perspective because you—well, you first of all need to find your way through the bidding documents and then, you also, of course, need to comply with all of the financial material prequalifications, participate in the

bid, do all the paperwork, the due diligence, and so on. So, this is not a problem for larger scale projects.

This is not a problem for larger scale actors. But it is—it can be a problem when you want to do auctions for small-scale projects or when you want to also include smaller scale actors such as community-owned solar PV. They might not be able to handle this very high administrative cost, so, this is something to think about when you think about which market segment and which actors you actually want to promote, support, with what time or what type of support mechanisms. There's also the risk of discontinuity of market development. This has happened mostly in the 1990s, and 2000—that some countries just put up one auction and then, project developers didn't know whether there would be any follow-up activities in this country.

So, this has been counterbalanced by governments indicating clearly how many auctions they want to run per year and over how many years in the future. As I mentioned before, there is a slightly higher risk for project developers—especially during the project development phase—which can also increase capital cost during this phase of the project. And, as mentioned before, there's also the risk of underbidding, lack of deployment, lack of target achievement. But this can be balanced by having very strict lead times for project realization and also having some penalties for non-compliance in place.

So, this was a very introduction to general auction design for solar PV.

Here's a very extensive reading list. As I mentioned before, there have been many publications on optimal auction design from various international organizations over the last years.

So, feel free to further analyze this, read this.

Thank you very much for your time. Very much appreciated this session done by the International Solar Alliance and the Clean Energy Solutions Center.

And, as always, you will now have some knowledge checks, some easy—hopefully easy questions for you to answer to see whether you actually understood the basic renewable energy solar PV auction design. Thank you very much for listening and I hope to hear you again in the next session—Session 11—where we look at some more in-depth design options for renewable energy auctions. Thank you very much.