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Introduction to Solar Policies: RPS, FITs, Auctions and Net Metering

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Webinar Panelists

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David Jacobs Hello, everyone around the globe. Welcome to the next session of the International Solar Alliance Expert Training Course. This session is an introduction to support mechanisms, for solar PV. We're dealing with the major support mechanisms, including renewable portfolio standards, net metering, feed in tariffs, auctions, but also, fiscal incentives and other incentives. So, please keep in mind—this is just an overview.

So, if you've already dealt with these support mechanisms before, it might be work taking a dive into the more in-depth sessions which follow after this first session. There's more in-depth sessions on all of the design mechanisms that you will find here. This is really just an introductory class for newcomers. As I mentioned before, this training course is organized by the International Solar Alliance in cooperation with the Clean Energy Solutions Center, who is assisting countries with clean energy policies, and also, providing low-cost expertise to policy makers in developing countries.

My name is Dr. David Jacobs. I'm very pleased to guide you through this session. And, as you know, this is one session out of many sessions which are part of this training course. So, just to give you some background—this is an introduction course, actually, for the first module and the second module. So, we're dealing with policies both for distributed PV and also, large-scale PV.

So, all the sessions, 3 to 9, on distributed solar PV and all the sessions, 10 to 13, on large-scale solar, as well as the session on the future of solar PV policies, 14 to 18, will be very irrelevant for you after you have watched this introductory class. So, here, a quick overview of this training session. First of all, we will define the learning objective. Then, we move on to a discussion of the major support mechanisms. In the end, you will get further reading so that you can learn even more about all of these finance mechanisms. And, last but not least, there will be a short knowledge check with multiple choice questions so you can test what you have learned so far.

So, looking at the learning objective, it is crucial for you to understand all of the different main categories of support mechanisms. I just want to stress, right from the start, that the terminology on support mechanisms is sometimes contested, because some people argue that it is no longer about support, it is just about a finance mechanism to allow a market design or a finance mechanism design that allows for refinancing capital incentive, power generation technologies—such as solar PV—and also others like wind energy. So, instead of talking about support mechanisms, some people argue we should rather talk about finance mechanisms, because the word "support" kind of implies that we're still in a phase where we needed subsidy. Just wanted to highlight this at the start—I'm still using the terminology "support mechanisms" because it has become standardized terminology in international discussions. So, just keep this in the back of your mind.

So, we're talking about renewable portfolio standards, auctions, feed in tariffs, net metering, and fiscal incentives, and also, other incentives that are able to reduce risk and therefore, also reduce financing costs. And this will be, then, the outlook part of this sessions. First of all, let's start with a quick overview of all the major policies used worldwide to support solar PV and other renewable energy technologies. Here's a graph adapted from a recent publication from IRENA, where you can see that you can actually differentiate this into regulatory and pricing policies and then, non-regulatory policies, and then, you have certain policies which are targeting all stakeholders, such as target setting, quote obligations with certificate gradings. This is what we're going to first of all look at.

And we have policies which primarily target large-scale generation, large-scale solar PV projects—mostly competitive—set pricing based on auctions _____, and, of course, also, administratively set feed in tariffs. And then, we're also going to discuss policies for distributed generation, and this is mostly about net metering, net billing, but also about administratively set prices, because, as you probably know, feed in tariffs, in the last couple of years, have been primarily used also to support smaller scale projects. And then, moving to the non-regulatory policies, you can see that we are talking here about fiscal incentives, tax incentives, capital subsidies, soft loans, but also about additional risk mitigation instruments. And a lot of research has actually moved to this part of the equation, because it has become clear that not really the selection of the primary support mechanism—be it feed in tariffs or auctions—it's really the size of parameter in order to reduce the cost for the renewable energy technologies. But, a lot of the other risk mitigation instruments—a lot of the more nitty gritty design of the overall policy framework—is much more crucial for reducing the costs of renewables than simply the choice between feed in tariffs, auctions, net metering, and so on.

So, this is what we're going to look at at the end of this session. First of all, I wanted to highlight with this graph from the latest—one of the latest global status reports from REN21 that most of the countries nowadays are using a combination of support mechanisms. And this is also very important for you to keep in mind—that you're not only operating with just one support mechanism, but normally, you have a variety. You're targeting different market segments.

So, for instance, net metering for roof mounted solar PV, feed in tariffs, or community projects, and then auctions for large scale or utility scale projects—just to give you an example of how you could potentially combine these support frameworks. Here, an overview again, from the latest REN21 report—how many countries are actually using what support mechanism. Interestingly, we have now almost all of the countries around the globe with renewable energy targets. We're going to take a more in-depth look at this later on. Also, interestingly, in the last decade, more and more countries have adopted renewable energy options for solar PV and other renewable technologies increasing from 27 countries in 2007 to now, 84 countries in 2017. So, in just one decade, you saw a lot of countries actually applying auctions for renewable energies.

However, feed-in tariffs are still the most frequently used support policy all over the world with 113 countries applying this policy. Only 33 countries apply renewable portfolios done this in combination with quota systems and certificate trading. And net metering—the interest in net metering policies has also increased significantly in the last years, now, with a total of 55 countries up from only 30 countries five years from now. So, there's a major increase in the use of net metering for smaller scale roof mounted solar PV approaches. So, first, let's take a look at renewable energy targets, renewable portfolio standards, and certificate trading, which has been implemented by most policy makers around the world.

First of all, you need to understand the different parameters when you design renewable energy targets. They can be technology neutral or technology specific. You can define them as a final energy consumption target or a total primary energy consumption target. You can also define it as a share of energy demand versus a fixed amount of installed class G—for instance, gigawatt hours or other units. You can also define it by sector—that you have specific targets for the electricity sector, specific targets for the heating and cooling sector, and for the transport sector.

And there's also the differentiation between long-term and short-term targets. We usually recommend to have both short-term targets, let's say, for 2020, 2025, 2030, but then, also, a longer-term outlook of how the power system will develop until 2050 or even beyond, because, as we all know, investment decisions in renewables are very long-term. Power plants can operate 20-30-40 years. So, knowing about the electricity mix in 20-30 years from now is very crucial for long-term power market planning. And then, of course, you can make renewable energy targets mandatory.

So, you would normally have to operate with some sort of penalty, and also, in order to operate or to operationalize this binding target, or you just make it aspirational and you include it as a, well, sort of voluntary agreement between government and industry that these and these targets should be reached by a certain date. Here, just a quick look, again, at how renewable energy targets around the world have spread. So, you can see here, for instance, a green bar shows you all the targets that have been set in the power sector. So, not even a little bit more than 10 years from now, in 2005, you only had 42 countries with renewable energy targets and now, you have 150 countries which have established renewable energy targets for the power sector. And what you can also see, of course, is that targets for the other sectors—heating and cooling and transports—are not yet as widely spread around the world as the power sector targets, also reflecting that we are front-runners in the power sector development and the other sectors are still lagging a little bit behind. But, this will probably also change in the next decade.

So, these targets can be implemented without any link to a specific support mechanism, however, renewable solar [Inaudible] portfolio standards somehow a variation of standard target setting. So, they also establish long-term trajectories for the electricity systems. They are normally mandatory and legally binding targets and they are then defining how the power sector will develop in the next decades. This can be defined as a percentage of the overall electricity demand or as a total amount of installed capacity by a certain date or total amount of electricity generated by a certain date. What you also should keep in mind is that renewable portfolio standards can also be made technology differentiated.

So, for instance, you can say, "We want to procure 100 megawatt of solar PV by 2020 and 500 megawatt of wind energy by 2020." So, this is a feasible way, even though, keep in mind, renewable portfolio standards are normally just setting an overall target, and then, the market—the industry if free to select the technology because of this mechanism which is designed to—well, it's usually, at least, 'cause technology's first. So, the advantage of renewable portfolio standards is that they set a clear timetable for the renewable energy deployment over the next decades. They, therefore, offer a certain degree of clarity, of how the market were developed. They also enable policy makers to balance the plans for grid expansion and the plans for expanding renewables.

This is especially important in markets where you have substantial grid constraints. So, you have to make—coordinate those approaches, grid expansion, and renewable energy expansions in order to not run into grid congestions in the end. And, as I mentioned before, if they're legally binding, they're also combined with fines and penalties, which can create some sort of discipline in the marketplace in order to really reach those targets. However, keep in mind that renewable portfolio standards, on its own, doesn't work, so, it is usually combined with a standard procure mechanism—that means with other renewable energy support mechanisms. So, when you, for instance, set a target of 20 per cent of renewable energies by 2030, then, your utility or the offtake or whoever is responsible then for reaching this target can either implement a feed-in tariff, an auction mechanism or also, certificate trading or even net metering in order to reach these targets.

And, in the United States and also in Europe, renewable portfolio standards are frequently combined with certificate trading, so, therefore, I wanted to take a look with you at how renewable portfolio standards in combination with certificate trading work. This is rather a complex mechanism, so, I could easily talk about this an hour alone. I will try to keep it to just five minutes so that you just understand the major concept of it. So, first of all, keep in mind that when you implement renewable portfolio standards with certificate trading, you are somehow separating two components of the renewable electricity of the solar electricity, and this is, first of all, the value that solar electricity has on the wholesale electricity market. So, you're selling, usually, your electricity on the wholesale electricity market.

However, you have a second source of income, and this is then defined by the market price of your certificate. So, for each unit of electricity that you produce, you get one certificate, one solar rack, so to speak, and you can then sell the renewable energy certificate—this solar certificate—on the nationally established or locally established certificate trading market. And based on supply and demand, based on how much demand there is for the certificate, a certain price will be determined, which, of course, varies depending on supply and demand. And, with these two components, the basic idea is that the solar PV produce—it can then make enough money to finance the system. The advantage of this type of mechanism is that this kind of increases the flexibility for compliance of a utility.

So, if they cannot generate renewable electricity on their own, for instance, they can also just buy the certificates from renewable energy producers and then, show the certificates to the government or to whichever unit is then responsible for controlling whether a certain target, certain renewable portfolio standard has been achieved. And if they show a sufficient amount of these certificates, they don't have to produce the electricity on their own. The idea is also that by having this flexibility—this compliance flexibility—this should also lower the total cost for renewable energy procurement, because you can go to the low-cost resources. So, you can go to a part of your country where solar PV is especially cheap, because you have good solar radiation, instead of just, well, installing solar PV next to the utility, for instance, where the solar radiation might not be as good.

And last, but not least, certificates which are then traded can also be used as a tracking mechanism.

So, in case you already have retail electricity competition established as part of your _____ of the electricity market, you can then also show to your final consumer that a certain share of the electricity that they are buying is from renewables. And maybe they will even pay you a premium for this _____ electricity. A major disadvantage of the certificate trading mechanisms, of course, is the volatility of the certificate prices. Here's a recent publication that analyzed the certificate price for solar renewable energy certificate—SRX—in different US markets. And, as you can see here quite easily, there's a large variation of the price that you get for your certificate on the certificate trading platform, which is, of course, a problem from a financing perspective, because as an adapt investor, as a bank, I will only give you—I will always assume the worst case—or very close to the worst case—and therefore, I will assume that you will only get the lowest level of the certificate price, which can make access to funds more difficult.

Or, if I give you finance for a volatility market like this, this normally increases the risk premium, and this increases the cost of capital, and therefore, it can also increase the cost of solar PV and the cost of other renewable technologies in the market. So, this is then our major disadvantages. It's lack of investment security due to the volatility of the certificate market, but also, due to the volatility of the wholesale market in general, because, keep in mind, you're selling a great component of your electricity on the wholesale market, which is volatile, and then, you're selling the green component of your electricity on the electricity trading platform, which is also volatile. So, both components of your revenues are volatile, therefore, risk premiums for debt financing are quite considerable, and those equity expectations are usually higher. Another disadvantage is that you normally just support risk cost technologies, because most of the certificate trading mechanisms have been neutral.

However, as mentioned before, this can also be changed. And, another frequently put forward criticism of quota-based mechanisms is a little dynamic efficiency—that you only focus on the most mature technologies, which is no longer such a big problem for solar PV, because solar PV has developed into one of the least cost technologies. However, when we were discussing quota-based mechanisms in the US, in Europe—mostly at the start of the 2000s, mid-2000s—2005-2006—solar PV was still a relatively expensive technology, so, there was a lot of fear that under these mechanisms, solar PV would not be financeable. This discussion of renewable portfolio standards and quote based mechanism versus feed-in tariffs is actually a little bit of an outdated discussion. This was primarily part of the discussion we had in the early 2000s.

Now, we have more moved to discussions where policy makers are debating the advantages and disadvantages between feed-in tariffs and auction mechanisms. So, this is also why we have not included an in-depth session on RPS and certificate trading in this training course. Therefore, let's move to auction mechanisms. Tenders or competitive procurements are alternative technologies which are frequently used, so, don't get confused if it isn't called "auctions" but tender is already mentioned before. Here, you see a list of—a map of the countries that are using or that have used auctions in the years, and it has increased from only 7 countries in 2005 to now 84 countries 10 years later—so, a very rapid increase of countries using auctions for solar PV and other renewable technologies.

How does it normally work? It is actually also quite simple. You normally have a government agency which sets a certain target—a certain procurement target. For instance, you say, "We want to procure 500 megawatt of solar PV in the year 2019." And then, what you then do is you receive bids from different actors in the industry—private sector bids, but maybe also public sector bids.

And then, according to the prices that are offered, you're ordering them more or less like in a general merit order, and then, you select all of the bids that are necessary in order to meet your targets, and then, the higher costs bids, which are no longer needed to meet your 500-megawatt target, are not even taken into consideration. So, this is a very basic mechanism how an auction works. When you look at to the more in-depth design of auctions, you can find a large variety of design features, which we will also discuss in two in-depth sessions on auction design. So, first of all, you have to define the procurement schedule—so, what will the auctions and when will it be auctioned? Will you have like, two auctions every year or four auctions every year and so on?

Then, you have to define the pre-qualification criteria. So, who's able to participate in the auction? How much of experience do you need to have? What kind of deposits need to make in order to participate in the auctions, and so on? So, there can be a large variety of financial and also material pre-qualifications for auctions.

Then, you have to define the selection criteria. So, you can only do it based on price, as shown in the last slide, but you can also include additional selection criteria—for instance, localization criteria, how much of the solar PV components have been produced nationally. Was it 20 per cent? 30 per cent? 40 per cent?

So, you can give additional points to bidders that have included higher shares of local content and so on, so, there's a lot of liberty for you to design the auction in this way. What is also then crucial is to determine the price finding mechanism, what mechanism will be used for determining the price that's shown in the previous slides. You can either say that every bidder that is within the auction volume exactly receives the price that they have offered. So, this would be called "pay-as-bid" pricing or you can also say, "No, it's not actually relevant what they've offered. Everyone actually gets the same price and the price will be determined by the last bidder."

However, keep in mind, most of the auctions worldwide are pay-as-bid, so, every project that has offered a price will exactly get the price that they have offered. But, we'll take a closer look at this in that session on auction design. Then, you have to define, also, the payment modalities. So, what type of payment will they receive? Is it a fixed payment per kilowatt hour?

Is it a premium based on top of the wholesale electricity market price and so on? And then, last, but not least—and this is very crucial—are the penalties for non-compliance or for not building the solar PV plan that has been auctioned? Because, in the early years—especially from 2003 to 2008—we've seen a lot of bad auction design, which did not include any penalties for non-compliance, and therefore, a lot of the projects were offered, but eventually, not built, and this, of course, led to problems for the policy makers, because they were assuming that the certain capacity would be available in a certain year. And this was then not the case and it caused problems for electricity market planning altogether. So, getting the penalties right is one of the most crucial design features of auctions.

Looking at the advantages of auctions—of course, cost efficiency and price competition is a major advantage of auctions, especially when you compare it with feed-in tariffs, because on the feed-in tariff, we still have the problem of so-called "information asymmetries"—meaning that the public sector, who's building the plan, has much more accurate information about the actual cost of the power generation, whereas the regulator, who is then trying to set prices administratively, has to get this information from various sources. So, if you've ever been part of setting—defining feed-in tariffs, you probably know how challenging it is to get the right information and even to forecast prices for the next couple of years. Because, when you implement a feed-in tariff, the tariff normally remains in place for a couple of years. So, you actually have to foresee prices for a year or two from now, which is also what participants in auctions do. So, when you see the auction results that have been published in the last couple of months and years—for instance—$0.01.79 cents per kilowatt hour for solar PV in Saudi Arabia—you always have to keep in mind that people that offer these projects are actually anticipating further cost decreases for PV nodules for inverters and so on.

So, they are also doing the same job in anticipating price decreases because the project will not be built—or will not start generating electricity and will not be built for the next 12 to 18 months. High investor security is, of course, also a large advantage. I already mentioned that the discussion has now shifted from RPS versus feed-in tariffs more to its auctions versus feed-in tariffs because auctions and feed-in tariffs both generate a high security for the investor, because they usually both result in long-term power purchase agreements over 20 years or more—sometimes even 25 to 28 years for solar PV. What is also at least a theoretical advantage of auctions is that you have more control of the volume, always assuming that each of the project that has been offered will also be built. So, getting the penalties right is very important in order to meet this target predictions of the renewable energy-based electricity supplier then much more easy.

And what is also interesting for many policy makers is that you can easily combine the support mechanisms with additional policy objectives as a measurement for local content requirements, how much of the solar PV models will be manufactured. You can easily build this into the pre-qualification or its evaluation criteria, and therefore also meet this additional power policy objectives. The disadvantages of auctions are also quite clear. It is relatively high administrative cost, because you normally need to set up a unit in your ministry, which will run the auction process, which will evaluate the bids that come in, and which will deal with all the power purchase agreements. So, the administrative cost is certainly higher than under feed-in tariff.

If you don't have a clear schedule of many auctions that you're planning over the next 5 to 10 years, then, this might also run the risk of discontinuity of markets. Stop and go cycles has been a major challenge in some European countries, but also, recently, in South Africa, for instance. And there's also the risk of not winning a project, and therefore, the finance cost—especially in the project planning phase—will be more expensive. So, the capital cost for your overall PV project is slightly higher than under a feed-in tariff because, especially during the project planning phase, when you still don't know where the project will be selected, it is much more difficult for you to get finance for this phase, and a much higher risk premium is normally then asked from debtor equity financiers. There's also the risk of under met bidding if you have not established very rigid penalties so that prices that are too low will be offered and the projects will not be built.

And one of the major downsides of auctions—and this is also why it is normally combined with other support mechanisms like net metering and feed-in tariffs—is that normally, auctions—due to the relatively high administrative cost also from the project development side and due to the higher risk during the project development stage; therefore, small actors, community based, solar projects, roof mounted solar PV projects, industrial and commercial sector—they're normally excluded because you really get just very low bids that normally win their auctions only with large scale projects which are normally financed by utility scale actors.

This was just a quick overview of auction design. Now, let's move on to feed-in tariffs. As I mentioned before, feed-in tariffs have been, and are still, the most frequently used support mechanisms for renewables and for solar PV. When we look back at the evolution of the solar sector, we see that feed-in tariffs played a very crucial role for driving down the costs of solar PV. Actually, when you look at the period from 2003 to 2011, Germany was this very attractive feed-in tariff for solar PV—actually absorbed more than 50 per cent of worldwide modules that have been sold during this period.

Then, the feed-in tariff in Germany was reduced significantly, and then, China actually stepped in and started to procure close to 50 per cent of overall module productions around the world. So, feed-in tariffs have really been a major driver in order to bring down cost to the level that we see today in the solar sector. However, as I said before, for the larger scale project, we see a lot of countries now also moving to a combination with auctions and using feed-in tariffs mostly for community owned and small-scale PV projects. The basic principle of feed-in tariffs is very simple. They are basically three main design features.

First of all, a purchase obligation so that the power producer knows that each and every kilowatt hour that is produced will also be taken and paid for. This is also defined as priority approaches, priority access to the market. What is, nowadays, more and more important is also the curtailment rules. So, under classic feed-in tariff, you would also be remunerated for each and every kilowatt hour that has been curtailed due to grid problems in the market.

Then, secondly, you would have a fixed price for each and every kilowatt hour that you produced.

As I said before, this is then calculated administratively by some unit in the responsible ministry. And last, but not least—and this is the third very important component of a feed-in tariff—it's about long duration of tariff payments. So, usually, ranging from 10 to 20 to 28 years, as in Spain. So, you know, by having these three design options, you know, actually, you can make a very easy calculation of how much money you will earn over the full lifetime of the PV project. Because you know each and every kilowatt hour that you produce will be taken and will be paid for.

You know the price that you'll get per kilowatt hour, and you even know for how many years you will get this payment. So, it doesn't take long to calculate the overall money that you can make with a solar PV project over a 20-year period. And this is a major advantage of the support mechanisms over other support mechanisms like renewable portfolio standards that we have discussed before. Of course, there's much more in depth design options, as well for feed-in tariffs. You can make them technology specific, which is the case in almost all countries around the world that use feed-in tariffs, because, of course, you have different power generation costs per technology.

Many countries have also made them size specific, because you have economies of scale. So, larger scale projects are normally less expensive. What you've also seen in some jurisdictions is location specific tariffs. So, in countries where you have a large variety of solar PV resources, you can say you get a slightly lower tariff in areas with very good solar resources, whereas in other parts of the country where you have less sunshine, you will get slightly higher tariff. However, you always have to keep in mind the advantages and disadvantages of this location specific tariffs.

A major advantage is, of course, that you have a more evenly spread of solar PV projects all over the country—also leading to less potential grid congestions—however, the economic efficiency of the overall support framework would be reduced, because you're also support solar PV projects which will not be installed in the best resource locations. Another very important design feature is feed-in tariff digression—that means an automatic reduction of the solar PV tariff in the future years. So, this does not affect existing projects that have already connected to the grid, but instead, you save, for instance, for projects that will be installed in 2018, you'll get $0.05 per kilowatt hour. And then, for projects that will be installed in 2019, you'll only get $0.04.9 per kilowatt hour for the next 20 years. That's already assuming certain technology learning, further cost reductions, for a major part of the components, further streamlining of the market, and therefore, also, reduced soft costs.

And last, but not least, we frequently also see capacity caps. We have some countries operating open feed-in tariffs that you do not restrict at all—how many gigawatt/megawatt will be installed in a certain year. Some countries have made negative experiences with this—for instance, Germany—where all of a sudden, the installed capacity was three times higher than the targeted installed capacity. And this is why most countries are now moving to either soft caps or hard caps on feed-in tariff deployment. The major advantages of feed-in tariff—we discussed them already before—high level of investment security; new actors are actually able to enter the market because of this very high investment security; also, smaller scale actors can enter the competition.

Because of this, community-based project have a chance to enter the market. PV price reduction and innovation can be triggered by digressive feed-in tariffs, so you're already assuming technology learning, and it allows, in a very simple way, for technology differentiated support, which, of course, is also possible under auction design. The major disadvantages—already mentioned before as well—is the uncontrolled market growth in case you don't have any caps or any type of digression schedule in place. It might also add a burden on your electricity price, however, this is no longer really an argument, because solar PV has developed into the least cost technology in many markets around the world. So, deploying more solar PV can actually help to reduce overall cost.

And what is also, of course, very difficult for policy makers is to anticipate the technology learning. I was saying that you can, to a certain extent, already include this by having a digression schedule of your tariffs and automatic reduction of the prices that you pay from one year to the next, however, the solar PV market has been so dynamic in the last couple of years that setting prices administratively has become really challenging, because it was very difficult. It was also anticipate—no one has expected, for instance, five years from now, that that cost of solar PV would reduce by 80 per cent. Maybe some analysts have said, "Maybe it will go down by 20 or 30 per cent" but 80 per cent, no one anticipated. And even on a year by year basis, it is rather difficult to anticipate the cost reductions in such a dynamic market environment.

So, these were the three major support mechanisms for large-scale solar PV. Of course, feed-in tariffs are kind of an inter-medium support mechanisms, because they can be both used for small-scale and large-scale systems. Now, let's move on to net metering, which is usually utilized to support solar PV on roof-mounted systems—so, smaller scale systems—up to one megawatt. So, here's just a basic concept. You need to understand—when we talk about self-consumption and net metering—and this is the concept of grid parity, meaning that the cost for generating one kilowatt hour of solar PV on your rooftop is actually the same as the price that you pay for the electricity when you purchase it by the electricity line from your utility.

This is then called grid parity, and many analysts—especially a couple of years from now—have said, "Yeah, once we reach this point of grid parity, the whole story is over. There will be solar PV deployment everywhere, and the market will stay changed fundamentally." However, now, a couple of years later in the game, we realize grid parity is, of course, an important benchmark, but it is not transforming the sector immediately, but it takes much longer than expected by many analysts. And one reason, of course, is that while grid parity—it does not really make sense to just look at the point when we reach grid parity; we also need to take into consideration that an investor—even a household or smaller scale commercial entity—does not only want to reach investment priority, but they also want to make a certain profit. They have a certain IRR expectation, and therefore, investment normally does not happen just when you reach grid parity, but maybe a couple of months or a couple of years later when you actually have already a considerable difference between the _____ solar PV on your rooftop and the retail electricity price.

Just to get some major difference between net metering and feed-in tariffs right—in the purist way, a feed-in tariff would result in a situation where you export all your electricity to the grid. This has been the case, for instance, in Spain in the early 2000s. When the feed-in tariff was adapted, solar PV prices that you were getting with the feed-in tariff were so high. They were so far higher than also the retail electricity price that you would pay from the utility, that you would export 100 per cent of your electricity into the grid. And then, in differences, net metering is actually an approach where you try to maximize self-consumption and you only export the excess electricity.

And so, what is generated in certain hours, certain months of the year—certain hours of the day, certain months of the year—this would then be exported to the grid and you would hopefully get a certain remuneration for that. Of course, this differentiation no longer exists, so, there's also a combination of these mechanisms. We will have one session, for instance, about net feed-in tariffs, which have been implemented in some countries and also discussed in South Africa, for instance, which combine both mechanisms. And even normal feed-in tariff—classic feed-in tariffs—as you see them in Europe are now actually a combination of self-consumption and exporting certain amounts of electricity to the grid. So, this is really just a very generic differentiation between those support mechanisms.

Net meterings exist already for a very long time. They have been implemented in the early 1980s already in the United States. And also, as I mentioned before, they have increased significantly around the world from only 13 countries in 2010 to now 55 countries by the end of 2016. As you can see here from this map, it has been primarily also used in the United States where 41 states out of the 52 states are currently using net metering. However, here, just a quick overview of all countries around the world that are currently using net metering, and you can actually add a new country to this almost every month by now.

So, let's look at the major design features of net metering. First of all, what you would normally see—so, maybe let's just take one step back. So, on net metering, you try to maximize self-consumption and then, you feed some electricity into the grid. And the question is how do you actually design this mechanism? What is the size of your PV system? How much can you feed into the grid and how much money will you get for this?

So, first of all, in many markets around the world, you see program-sized caps. So, we normally talk about net metering programs. So, they are sometimes limited either as a percentage of peak demand in a certain country.

So, for instance, 5 per cent of peak demand, so we can install, let's say, 5 gigawatt of solar PV until it reaches of 500 megawatt of solar PV. Or, sometimes, they're also defined as certain capacity limits—so, the net metering program will only work until we've reached a total capacity of roof-mounted solar PV systems equally 500 megawatt.

In some cases, they're also unlimited and no clear program size cap has been defined. In addition to this, we frequently see, also, system size caps, depending also for which market segment the net metering is designed. If you have a net metering program which primarily targets the residential sector, then, you can say, "Oh, the maximum solar capacity per unit is maybe 10 kilowatt or 5 gigawatt." If you were targeting more the commercial or the industrial sector, then, you might want to say, "The maximum size of each system will be 500 kilowatt or even a megawatt." Some countries also say that it's not really about a fixed number of kilowatts installed; it's about the maximum allowable level of distribution level penetration per circuit.

So, for instance, you can say, "Well, in this electricity circuit, we can only absorb a certain amount of distributed generation and a certain amount of rooftop solar PV and therefore, we're limited at 15 per cent of the maximum demand in this region." Or, as I mentioned before, it can also happen without a system cap in this case. What is then very important is the so-called "rollover provision". So, under net metering system, you're sort of using the electricity grid as a storage unit. That means that, for instance, you are producing solar PV electricity at daytime; however, you're not just home, so, you're not using your air conditioning, your fridge—whatever it is.

So, you're feeding in electricity during this day of the time, and then, when you come home at night, you're no longer producing solar PV, however, you can then get the electricity from the utility, and it is then rolled over. The electricity that you produced during the daytime you can then use it at the night time, and you don't have to pay for it. So, you're only being billed for the net electricity consumption at the end of the billing period. This is, of course, also where the name "net metering" comes from.

So, you would then say, "Well, we have a yearly billing period, and therefore, we also have a yearly rollover period."

So, you're just comparing all the electricity consumption during this period. You then look at how much electricity you have self-consumed, and you're not paying for the electricity that you have been able to rollover during this period. The last and very important question is the rollover mech—the payment for the rolled-over electricity and also, the payment for the excess electricity. There's very different approaches. The standard net metering 1.0 approach, as we call it, is classic retail electricity price rollover.

So, you really just look at, "What does a unit of electricity cost for me in each hour? So, I get the same amount of money for each and every kilowatt hour that I feed into the grid. Then, I also pay for my utility for purchasing this electricity." However, this has become much more elaborate in the last couple of years. There's many utilities that says, "No.

Actually, the value of your electricity that you feed into my grid differs from time to time or it is not the same as the retail electricity price that you're paying, because I also have to cover some system costs for upgrading and managing the electricity grid, for instance. So, therefore, you're not getting the whole retail electricity price, but, you're only getting the wholesale electricity price or the avoided costs." So, by looking at this design feature, we're actually moving into net metering design 2.0 or 3.0 and we will have a more in-depth discussion on all the various design options here in the in-depth session on net metering design. Now, just a quick overview on the financial and fiscal incentives that exist for solar PV and renewable energies. One very basic design is grant programs so that you give you out money for buying/purchasing solar PV system.

This is normally defined as a percentage of the total system cost, total installed cost of a project. For instance, in Germany, back in 2003, you got a grant from the government which was up to 60 per cent of your total solar PV cost, which was then normally financed via the tech state budget. However, keep in mind, that this type of grant programs were primarily used for solar PV while it was still a young and relatively immature technology. Nowadays, these mechanisms actually no longer exist. They sometimes still exist for solar PV in off-grid areas because we're still facing some problems with high upfront capital costs in these areas, however, for grid connected solar PV, these programs have almost all ran out.

You can also have tax incentives—for instance, exemptions for import taxes. This is normally one of the first steps that developing countries are taking in order to allow for faster and more immediate deployment of solar PV in their countries. Sometimes, they still have very high import taxes on, well, many electrochromic goods, and this would then also include PV systems. So, the general recommendation is always to get rid of this import taxes and, by those means, start a quicker development of the markets. Nowadays, it's also very important for the off-grid renewable energy market because of a lot of the appliances, but also, of the components that are used for mini-grids for solar home systems still have to face high import taxes. And this, of course, can delay energy access via off-grid and mini-grid system quite considerably.

What is frequently used as well is accelerated depreciations. So, even though your solar PV system will be running for 20-25 years, governments might allow you to already write off all of the costs in the first 5 years, which can give you a very significant financial benefit. We also see tax reductions adopted to direct taxes like income tax or corporate income tax that also exists in many countries around the world. In the United States, we've seen a lot of development in solar PV sectors spurred by tax credits. So, either reduction tax credits that you get based on the annual amount of electricity that you generate or investment tax credits depending on how much your total investment in solar PV was.

And you can get up to 35 per cent at state level of investment tax credits and reduction tax credits, which have also been a major driver of the very low auction results that we have seen for solar PV, but also, for solar PV plus storage. In the last couple of years, in the United States, when you look at the costs that solar has been procured for in the United States, please, always keep in mind that tax credits are playing a crucial role in further driving down the costs in general. They are more or less the same as direct investment incentives that we have discussed before, however, they have a certain delay. The financial benefit will come in one or two years later, once you actually started generating electricity and making your next tax claims. Soft loans are also used in many countries around the world.

So, you're trying to reduce the cost of capital, the cost of debt here. Soft loans or concessional loans are both used in the so-called developed countries and developing countries. They can increase access to capital and lower the cost of debt. They can also prolong the debt term, which, in developing countries, is frequently as low as 8 or 10 years. However, with soft loans, you can also reach longer term debt grants—12-15 years, maybe.

Some critics say that if you keep soft loans in place for too long—for instance, by state-owned banks—they might actually lead to a situation where public financing is crowding out private financing. However, the experience in many countries has actually been different. By offering soft loans through state-owned banks, you've actually created a situation where private banks will then follow the lead and also adopt similar, attractive loans because they see that renewable energy projects, PV projects, are not as risky as previously assumed. And also, having a first pipeline which is financed by soft loan backed projects can also help to reduce the overall perceived risk of this technology—of solar PV. Then, we have additional risk mitigation instruments, and this is really something I could also talk about for at least an hour.

I just wanted to highlight that in this session, we have primarily talked about this price discovery mechanism, which is like the very top of this pyramid here. We recently wrote a report about this, which you can also find in the further reading section. So, we've been really just discussing the very top of the iceberg. However, when you want to make sure that you get a low-cost renewable energy procurement, you have to keep in mind that a lot of other factors are equally important to reduce the cost of procurement—and these are contractual factors, regular factors, and market factors—which play a role, of course, next to the general technology evolution. So, solar PV is getting less and less expensive, and, of course, it also depends on the resources that you have in your country.

But, there's actually—with the contractual, regulatory, and market factors, you have three aspects where the policy maker can actually influence the cost of solar PV in the country. So, I quickly wanted to take one minute each to highlight these factors. When we talk about regulatory factors, we're talking about a stable, regulatory, environment in general. You should establish streamlined permitting administrative procedures. These can sometimes alone already reduce the cost of solar PV by 5 or 10 per cent.

Land access is, of course, also very crucial. Sometimes, you have countries where you see a lot of speculation on land, which might be used for solar PV, which will then, of course, increase the cost for generating electricity with solar PV. Grid interconnection procedures should also be streamlined and, if possible, adopt a shallow, grid connection charging approach so that a PV project developer will only have to pay for the grid connection line to the next already existing grid connection point. And there's, of course, also other factors. Looking at the market factors, the overall size of the market will play a crucial role in also knowing how the market will develop, so, target setting is very important.

When you compare the cost of solar PV in your country with recent bids in Saudi Arabia and Mexico and Morocco, please, also, keep in mind the project size. These very, very low bid prices that we've seen communicated in the media are normally for multi-hundred megawatt or even gigawatt size PV projects. So, this, of course, leads to additional economies of scale and further helps you to reduce prices. One of the most crucial aspect is the cost of capital. We discussed this already.

Also, the presence of qualified workforce will help you to lower cost for solar PV, and, of course, the presence of key supporting infrastructure like roads for transporting the solar PV _____ to more remote areas will also play a crucial role on the total overall cost of solar PV in your country. And last, but not least, let's take a quick look at important contractual factors. Of course, there's solvency and the reliability of the off-taker—so, of the institution which is paying money to independent power producers. This is very important. This has a very significant impact on the risk perception by banks, and this also determines the cost of capital quite significantly.

Contract duration is very important. When you sign a power purchase agreement for 10 years, it has a significantly higher price than a power purchase agreement for 25 years. Payment structure also has an influence. Inflation indexation can be very important in countries with high risk of inflation. Some countries even denominate PPA contracts in internationally more accepted currencies like US dollars or Euros instead of signing them in the local currency in order to mitigate currency risk.

And, as mentioned before as well, dispatch and curtailment rule—so, what happens if one kilowatt hour that I produced with my solar PV plan will not be bought because there's certain grid constraints—so, regulations on what happens then, "Will I be compensated for this? Will I be fully compensated for this? Will I only be partially compensated for this?" This will also, more and more, affect also the bankability of solar PV projects in the future. So, that was just a quick overview of the 16 major factors that might also influence the cost of capital of solar PV projects.

Here, also, interesting further reading—a study by UNDP, from 2013, which has looked at several aspects for de-risking investment and renewable energies. Here, an example, again, from Kenya, from the same study, where you can see how certain risks in a market can actually lead up to a significant increase of the cost of equity, but also, to the cost of debt. So, if you're able to minimize these risks, you can minimize the cost of capital, and therefore, also reduce the overall [Inaudible] solar PV in your country. So, this was overview of all the important design mechanisms, support mechanisms for renewable energies. You have a lot of reading material here on overall policies, on auction design, on feed-in tariffs, on net metering, on renewable portfolio standards, and additional list of references.

So, thank you very much for your attention. Please, keep in mind, this was only an introductory session. You will have much more in depth discussions on each of these support mechanisms in the following sessions. So, stay tuned, and see you soon. Thank you very much.