CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Introduction to Solar Subsidies

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For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Presenter

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Toby Couture Welcome to this International Solar Alliance Expert Training Course. This is session eight as part of this training series focusing specifically on solar subsidies. This expert training series is a joint collaboration between the International Solar Alliance and the Clean Energy Solutions Center. This training is part of Module Three, as you can see here on the slide, and focuses specifically on the issue of solar subsidies. This slide provides a brief overview of the presentation as a whole.

We'll start by looking quickly at the learning objectives. We'll take an in-depth look at the history of solar subsidies—where they come from, the various forms they've taken. And then, in the third section, we really provide a broad overview of the many different kinds of solar subsidies that exist—what we mean by solar subsidies, what are some of the arguments on both sides of whether certain policies are actually subsidies and which ones aren't. And we'll provide some concluding remarks looking at the big picture—what does this mean for the future of solar power and how can governments best navigate a world in which solar is increasingly one of the cheapest electricity supply options? And then, ultimately, try to address the question, "Do we still need subsidies? Does the solar industry—what is the future of solar power policy?"

And then, finally, at the end, you'll have a quick snapshot of some further reading as well as a knowledge check with a number of questions. So, that said, let's dive in. As I mentioned, we'll be looking to try to understand the history renewable energy subsidies with a focus specifically on solar power. We'll look at the various forms of subsidies that exist. We'll try to understand how subsidies have evolved over time—in particular, as renewable energy costs have declined and solar power costs, in particular, have declined, and we'll take a look at the future of renewable energy subsidies, as well as the

role of both market design and the overall framework conditions in supporting the scale up of solar power.

And we'll examine the idea that the overall concept of subsidies likely needs to be revised in light of rapid cost declines and in light of changing market conditions. So, hopefully, by the end of this, you'll have a more nuanced understanding of what we mean by solar subsidies, and you'll be in a better position to engage in debates and issues concerning the future of solar power policy. So, first, a definition. According to the Oxford English Dictionary, a subsidy is a sum of money granted by the state or another public body designed to help an industry or business keep a price of a particular commodity or service low—that is, lower than it otherwise would be. As two sub-definitions, they add here, "A sum of money granted to support an undertaking that is held to be in the public interest": and, second, "A grant or some contribution of money, simply."

Dictionary.com provides a similar definition. "A direct pecuniary aid furnished by a government to a private industrial undertaking—a charity or the like. It's usually given to promote commercial enterprises." Now, with this definition—or these definitions—established, you can understand that solar power and solar power subsidies have qualified for grants or contributions, public support of one form or another, over the years, largely because solar power is deemed to be in, broadly speaking, the public interest. Solar power is abundant. It is widely available in virtually all parts of the world.

It is clean and it is renewable and particularly, after the oil crises in the 1970s and within a number of concerns over rising energy prices and global climate change as well as geopolitical considerations, a number of countries around the world have been keen to support the use of solar power—again, partly to promote energy security and other objectives, and were prepared to subsidize it, particularly in the early stages when the technology was still very fledgling and not yet fully developed and not yet fully commercial. So, with that foundation set, we'll use this particular training series to really dive in to the various forms of subsidies that exist and that have been used in different part of the world. It's important to note at the outset that the term "subsidy" is often used pejoratively—that is to say negatively. Subsidies are often thrown around used by critics to refer to an industry that is not mature, or to criticize an industry that is not mature. Subsidies are frequently equated with some form of market distortion—particularly among economists—and they indicate that a technology—or they're designed to indicate that a technology is expensive or not yet competitive.

And, as such, many critics often argue that subsidies should be phased out, they should be removed—that solar, in this case, shouldn't be subsidized because it contributes to market distortions and the debate rages on—and I'm sure, in your various countries, wherever you are in the world, you've heard this debate in one form or another. Now, interestingly, in recent years, a growing number of solar power projects have been heralded as being subsidy free, and we have a special training session—number 15—diving into that top in particular, where we really take a look at subsidy free solar and what that

means. This presentation should ideally be listened to prior to the subsidy free solar presentation so that you have the foundation in place to really understand the key issues and topics at stake. But before we get into that, let's have a closer look and also get a bit more perspective on the issue of subsidies. It's important to highlight, also, at the outset, that the vast majority of subsidies in the energy sector have gone to fossil and nuclear technologies, not to solar power.

So, if you look here, this is just one snapshot from the US. Many governments around the world—virtually all governments around the world—subsidize the energy sector in one form or another, either directly with public money or indirectly by failing to internalize various environmental and other externalities, but this graph here really refers jus to the explicit government subsidies, not externalities and the like. And you can see here that oil and gas, on the far left, has been the largest single beneficiary over that period—from 1947 to 2009—followed by nuclear, and then, biofuels, followed finally on the far right by _____ renewables—non-biofuels renewables. So, in the US—and again, this is the case in many, if not virtually all, governments around the world, it's important not to forget the vast majority of subsidies, again, go to sectors other than solar power and to sectors other than renewables. So, it's always useful to put that into context as we dive into this.

Now, looking at it historically, some of the first efforts to support solar power were in funding publicly supported R&D—or what is called Research and Development—and this has remained a mainstay of solar powered subsidies in governments around the world. There are a number of publicly funded national laboratories, many of which have conducted groundbreaking research and innovation in the solar sector and has really been instrumental in helping make solar power be efficient and cost-effective technology that it has become today. The emergence of the public laboratories has also played a really critical role in spreading awareness about solar power. Now, I've included two examples here; there are many others—the Solar Energy Research Institute, which later became NREL, and the Fraunhofer Institute in Germany, both founded in the early 1970s—to support research specifically on solar power and other technologies. But, as solar power became a more mature technology through the 1990s and 2000s, particular efforts have shifted beyond R&D into actual market support policies, such as providing purchase guarantees or forms of forms of price supports—what are sometimes called "minimum pricing policies" like, feed-in tariffs, as well as other policies like, renewable energy certificates and renewable energy mandates in order to scale up the market further.

Now, as that has happened—particularly through the 1990s and 2000s—solar power subsidies have also grown along in the process and, as a result, they've come under increasing pressure from policy makers, rate payer advocates, and other interest groups—particularly in—I've cited a few examples here, but you could certainly add more to the list—Spain, the Czech Republic, Germany, the Philippines, the US, and others. So, we've seen solar power come under criticism for being costly, for imposing costs on rate payers, and

we've heard calls to reduce those subsidies from a number of different corridors. Now, solar subsidies were a core part of what is sometimes referred to as the "early commercialization phase of RE development"—of renewable energy development. And you can see here in this graph—although the resolution isn't terrifically clear, you can click on the link and get the original from the full report—you can see here three different phases of renewable energy policy development—this early commercialization phase, this middle phase of policy support, followed by what's referred to here as the policy framework phase. And you can see that all of that traces against the declining renewable energy cost range.

So, as renewables get cheaper, as technologies like solar get less expensive, the policies used evolve along with them. And, in general, as a trend, we've seen explicit subsidies become less important, less frequently used, and more and more governments simply adopting frameworks—regulatory frameworks, permitting rules, grid access rules—simply to allow solar to be developed rather than to explicitly subsidize it in the traditional sense. And we'll try to unpack that debate a little bit more in the slides that follow. As solar policy has evolved over time and as subsidies have evolved over time and taken different shapes and forms, it has become unclear which policies actually constitute a subsidy and which do not. And that's really at the heart of many misunderstandings in the solar industry, and many newspaper articles continue to refer to various subsidies in the solar sector that may not accurately be described as subsidies anymore.

And again, we'll get into that debate a little bit more in the slides ahead. The key question here—I've tried to summarize a bit tongue in cheek with this slide referring to the old Zen koan—"If a tree falls in the forest and nobody is there to hear it, does it make a sound?" The question in our case here being, "If a feed-in tariff is offered at, say, $0.02 per kilowatt hour, is it still a subsidy?" And I think this question really cuts to the heart of the debate around renewable energy subsidies. If solar is the cheapest technology on the market—which, in many parts of the world, it increasingly is—and the government says, "We want to mobilize investment and we're prepared to offer long-term contracts at below market prices"—let's say at below spot market prices like in, for example, in the Middle East, where power systems are dominated by oil and gas—often subsidized oil and gas—if solar can compete and produced power at say, $0.02 or $0.03 a kilowatt hour and the government decides to offer long-term contracts for that, is it still fair to call that long-term contract a subsidy if it's cheaper than everything else and if it's actually rate payers who are ultimately paying for that cheaper power and not the government itself?

So, again, there's a host of issues and nuances here that often don't get picked up or don't get appreciated by journalists writing in this space, and I think it's really a critical component of the debate and it's one that we need to have, because solar is increasingly cheap, and some of the criticisms around subsidies are increasingly outdated due to the new cost realities. And again, we'll unpack this a little bit more through the slides that come, but it's important to keep this background question in mind. So, it's important to

distinguish between what are sometimes—what we can call "classic subsidies", and I've listed a few here where few would dispute that these actually are subsidies—where the definition is clear and it's clear that it's a government support and it's clear that it's preferential treatment to the solar sector. So, I've listed a few here. Rebates, tax incentives—which are still used in many parts of the world, including in mature markets like the US—government backed loans or government backed power purchase agreements, cash grants—where actually parts of the—you can get a direct cash grant for investing in solar power—these are really classic subsidies and can fairly be described as preferential treatment or subsidies to the solar sector.

Now, it's important to distinguish those from what I've referred to here as the overall regulatory framework in which solar investment takes place. It's less clear that some of these are actually accurately described as subsidies. And again, I've provided a short list, but we will continue to get into this in the rest of the presentation—guaranteed grid access; the presence of long-term stable contracts—like the power purchase agreements; the overall market design; as well as the presence of things like the guaranteed off-taker—someone to actually buy the power rather than operating on a purely merchant basis or spot market basis where the supplier just essentially sells into the open market. So, there's a number of important questions to be asked here, whether these are some of these different regulatory elements—in other words, aspect of the broader operating environment in which solar power projects are built—actually constitutes subsidies. And, I think in most cases—at least definitionally—we would argue that these are not, explicitly speaking, subsidies.

They create the framework conditions in which investment takes place. They may give priority, for example, to low emissions technologies or zero emission technologies. They may also favor technologies with zero marginal costs. If the market is based on the traditional merit order, where the cheapest technology bidding into the market gets dispatched first, you could argue that's preferential treatment, but ultimately, that's fundamentally a function of market economics. If a technology has zero marginal cost, it can enter into the market at zero—at least during some of the hours of the day as needed in order to get their electricity dispatched.

So, again, there's a host of issues here to unpack that often get lost in the debate around subsidies, and hopefully, this presentation on the introduction of subsidies can help set some of these issues straight and at least provide a bit more clarity into the debate. So, an example. Does the existence of contracts represent a form of subsidy? So, any kind of contract—let's say a 5 or 10-year or 20-years feed-in tariff that's set at—let's take our notional $0.02 per kilowatt hour from the previous slides. Some would argue yes; some would argue no, and yet, long-term contracts do offer some kind of protection from wholesale market prices.

So, some would argue—many economists would argue solar power should be exposed to market prices. If prices go up, then, that's great. And if prices go down—even into negative territory—then, that's fine. Producers should take

on that risk. And they would argue that inserting long-term contracts into the market—into a liberalized electricity market—represents, therefore, policy support and can therefore be construed as a form of subsidy, even if the price is at or near market prices.

Now, this really comes back to the earlier point that was made around subsidies being—representing some form of market distortion, and that's really at the heart of this particular debate. Do contracts "distort" the market and does that represent some form of subsidy? Now, while that debate remains open—and you can take various positions on that—the second component of this seems to be a little bit more clear. What if the contracts are signed by private companies—for example, corporate PPAs? As we've seen a number of companies around the world do in recent years, they have signed private contracts with renewable energy producers locked in at a particular price over a particular period of time to supply their own operations.

Does that represent a subsidy? In this case, presumably not, because these are private transactions agreed in an open market. In other words, the government is not the one setting the price and the government is not the one determining the terms of those contracts. Now, it needs to be said that those contracts still operate in a regulatory framework, so, there need to be rules around access to the grid. There needs to be rules around what to do in certain conditions of contract dissolution.

What happens if there's excess power that needs to be injected into the grid? All of those things still need some kind of regulatory treatment and regulatory and legal clarity. But strictly speaking, privately signed PPAs would not represent a subsidy, even if the price is higher than the market price, because these are private transactions agreed in an open market. What we typically mean by solar subsidies are when the government is intervening explicitly in the market and supporting a particular technology. So, with that said, let's dive in and look at the menu of the main solar subsidies that have been used historically.

The first is the one we also started off with at the very beginning—research and development. Many governments around the world have invested and continue to invest in R&D for solar power. R&D helps improve the technologies and make them more efficient, and it has played a critical role in making solar power a competitive power source worldwide. And this remains one are that continues to benefit—at least in many countries—from some kind of public support in so far as national laboratories benefit from public subsidies and are not funded by contract work or other forms of private contracts.

Number two—investment subsidies. Many countries around the world offer direct investment subsidies or what are sometimes called "cash grants" or "rebate programs" for solar power. These are typically awarded on a dollars per kilowatt basis on the basis of the total capacity installed. And here, you see the distinction between what are traditionally called "capacity-based incentives" versus production-based incentives. What we mean here by "investment subsidies" are primarily capacity-based incentives.

So, these are designed to reduce or buy down the cost of the solar system, usually by covering a percentage of the system cost or simply some dollar amount of the system cost. Often, these include caps on the total per project subsidy that can be awarded, so, you can get, let's say, $1,000.00 per kilowatt installed up to a maximum of 4,000 kilowatts of subsidy, for instance—or $4,000.00 of subsidy. So, in that sense, you could have—you make the technology more affordable, you make it easier for people to afford the upfront cost, and you can encourage wider adoption. Now, interestingly, although investment subsidies like this were widely used in the beginning of the solar industry's development in the 1990s and early 2000s, there are some governments around the world today that continue to use these kinds of capacity-based incentives. I've said it here—a couple examples from the US and from France, and this shows that even these traditional classic subsidies are still in use and, to many in the industry, this remains surprising, given particularly how cheap solar has become.

Now, one could argue that there's a case to be made—particularly in lower income countries—where there isn't as much disposable income, where the upfront cost may really be too much—even for medium income households to afford. If the government wants to support more development, they could introduce capacity-based incentives to try to buy down the cost and make it more affordable, but one key disadvantage that is repeated time and again with regard to these kinds of incentives is they have the unintended side effect of actually just increasing the price of solar to customers. In other words, the industry doesn't pass on the full rebate or full subsidy to the customer. Rather, they price their systems more expensive to get in on the action and actually gain a portion of that subsidy for themselves. And this is broadly corroborated by both the US and France, both of whom have higher than average installed cost when compared to neighboring jurisdictions with very similar markets and very similar labor forces.

So, this is one reason why a number of critics, a number of analysts, have argued that capacity-based incentives like these are outdated. Subsidy tools, then, should broadly be phased out. And this is, again, a debate that rages on. There are some who still speak in favor of these kinds of subsidies, and, as I point out here, these do remain widely used, but it's important to underscore that they are becoming less commonly used as the technology has matured.

A third—which is related to the previous one—is simply tax incentives. Many countries around the world provide special tax incentives for investing in renewable energy technologies. These take a number of different forms. They can be an investment tax credit, a production-based tax credit—both of which continue to be used in the US as well in different forms in markets like India and in Kenya. And there are also various forms of preferential tax treatment that can be tucked away into the tax code, such as accelerated depreciation as well as special tax exemptions.

Now, with aspects like accelerated depreciation, these are often broader tax provisions that are available to all or many different kinds of capital investment, not just solar power, and, in that sense, they may not be seen as

a form of preferential treatment, because they are, essentially, a broader tax provision that's available to a wider subset of capital investments of which solar power is one. So, there's some debate there. Another more obvious one is simply tax exemptions, where there's, for example, VAT exemptions on solar components. We see these kinds of tax exemptions particularly in emerging markets now. There are many VAT exemptions on solar components, solar panels, solar wiring, solar inverters in some cases, in markets throughout Africa and parts of Latin America, and the attempt there is, again, to encourage the industry by reducing those levees on solar technologies.

So, those—you could argue those kinds of tax incentives and tax supports do qualify for subsidies or do qualify as subsidies. The fourth is low interest loans—what are sometimes called "soft loans" or "concessional" loans. Many governments have provided solar power with these kinds of soft loans or low interest loans that include both a preferential interest rate as well as a longer loan duration. And these have been critical to supporting a number of markets around the world, including Germany's distributed solar market, so, via the KFW, Germany has supported—and continues to support—investments in solar power by offering preferential loans, low interest loans. The KFW is a government backed bank, and these loans remain part of the landscape now.

They are currently also available in Germany for energy efficiency investments, improving the energy efficiency of your home. They're available for energy storage and other technologies. So, again, this isn't solar specific, but this shows one way in which governments have supported—and continue to support—investment in technologies like solar. It's important to underscore that in many emerging countries, low interest loans—or at least making such soft loans available from a government backed source—can be a powerful way to catalyze the market, because in many cases, commercial banks do not invest or are very reluctant to issue loans for solar power for a host of reasons, and these kinds of government backed banks of government backed loans can play a critical role in unlocking the market and really getting local banks more comfortable with investing their own funds in solar power in the future. So, there's a case still to be made—particularly where the banking market is less developed or where the overall access to loans is constrained for this kind of low interest rate support—that these do remain essentially a form of technology specific or solar specific support when they're targeted at solar power and, as a result, these are, in the classic sense, a form of subsidy.

Moving on to the fifth. In some jurisdictions, governments introduce mandates. Mandates requiring that a certain building type or that new construction starting in 2020, for example, has to introduce, has to incorporate either solar PV or, for example, solar hot water systems according to building codes. So, there are ways—much like with energy efficiency building codes or light bulb energy efficiency standards. We're seeing a growing number of jurisdictions move in this direction with regard to mandating solar power—so, setting, essentially, the requirement that buildings integrate solar power into the actual building requirements for new construction.

And we've also seen governments introduce mandates on themselves for public buildings. For example—all new government buildings beyond a certain size would be required to adopt solar on their rooftop, either hot water or PV. And these kinds of mandates are designed typically to encourage solar power in applications that already make economic sense, but where the market is not acting or where the market is growing or reacting, let's say, to that economic reality. So, typically, governments are hesitant to introduce mandates because mandates are often seen as being fairly heavy-handed measures. They force the private market to do something that they otherwise aren't doing, and, as such, governments typically do these or introduce mandates like these in applications that already make economic sense.

And one prominent example of this is in the solar hot water sector. Countries—a number of which are listed here—have introduced specific mandates because it just makes economic sense and there's no reason why the government shouldn't require this for new construction, because it's cheaper to heat water—at least preheat water—with the sun than it is to use non-renewable resources—like gas or otherwise—to heat water. So, again, this is often connected to energy security and other considerations. Similar logic applies with the solar PV mandate, of which I've listed two here—both France and California.

Moving on to number six—direct government investment. In many cases, governments choose to directly invest in solar power—either freestanding pilot projects or to supply government buildings, national parks, and other public facilities. This remains a form of subsidy that governments continue to use by investing public dollars directly in solar. This also takes different forms, however. In some cases, the direct government investment is in the form of free land or by covering the bill for grid connection costs, for example. A number of governments in the Middle East have offered to cover the grid connection cost on large-scale desert based solar projects, and that is one way in which direct government investment can effectively subsidize the total cost of solar.

And, of course, in many parts of the world, governments continue to invest directly in solar as part of rural electrification projects. And one could argue these are also—this also represents a form of subsidy.

Moving on to number seven—feed-in tariffs. As we saw in session five on feed-in tariffs and feed-in premiums, feed-in tariffs involve setting a cost-covering rate for the purchase of solar power. These cost-covering rates, where they result in additional cost, are typically passed on either to rate payers, as in countries like Germany, or on to taxpayers, as in the Netherlands. If the feed-in tariffs are indeed above market prices, above retail prices the customers pay, for instance, and it does result in excess cost or surplus cost to rate payers, then there's a good argument to be made that this represents some form of subsidy, because this represents an intervention in the market. The government is requiring utilities to purchase this renewable power via a feed-in tariff, which is essentially just a long-term contract for power supply at a government set rate.

Feed-in tariffs, in that sense, due to the fact that they are a market intervention, are considered by many to be a form of subsidy. And, by economists—or by a growing number of economists—they are also considered a subsidy even if they're below retail prices and below utilities' avoided cost, because again, the government is the one setting the rate and not the market. So, depending on where you fall along that spectrum and how you see the role of government intervention versus what we've described here as classic subsidies, you may see this issue differently, and this comes back to our question—"If a feed-in tariff is set at $0.02 per kilowatt hour—in other words, cheaper than everything else on the grid—is it still a subsidy?" And I think that's really the—that gets to the heart of the debate here. I think it's more clear that feed-in tariffs are a subsidy when they are significantly—when they're above retail prices, and particularly above utility avoided cost or even above wholesale market prices.

The more interesting debate emerges when they're below that and whether, again, the presence of a long-term contract and a purchase obligation, for example, makes it, therefore, a subsidy, in the classic sense. And again, that's maybe where we need to nuance further the distinction between subsidies and the overall regulatory framework conditions. We'll get into that again in the conclusion of this presentation. Now, moving on to feed-in premiums, which are a more recent form of feed-in tariff that involve—instead of providing a fixed, long-term contract for the entire power supply, they provide a bonus or a premium on top of typically the fluctuating market price. And you can see a small graph here that just captures that basic dynamic.

And the feed-in premium can either be fixed or variable, but it essentially floats on top of the wholesale market price in this case. Now, in this case, with the feed-in premium, because it is an explicit top up above the market price that is typically not paid if the market price goes above a certain level, it still represents a top up, and therefore, still represents a subsidy. And I think that's where it's clearer or easier to define, to establish, that feed-in premium policies do represent a form of subsidy. They're also a form of preferential treatment in that not all power technologies—not nickel or nuclear or gas plants—don't all get premiums, therefore, there is arguably some subsidy at play here, regardless of which way you cut it.

Number nine—quota obligations—or what are sometimes called "renewable portfolio standards" or even "renewable energy standards". Governments frequently establish targets mandating a certain share of renewable energy in the power mix. Now, in contrast to one of the previous slides on renewable energy mandates, where a particular government mandates solar in a particular application or a particular type of construction, these obligations are more imposed on the overall power system. So, the renewable portfolio standard sets a legally binding target for a minimum share of renewable energy in the overall electricity mix that a given utility has, and these targets are—where they are legally binding, they are typically known as RPSs and not just targets. The key here is that in many jurisdictions, it's not just a renewable energy target.

There is specifically a solar—what is sometimes called a "solar carve-out" within the target. So, a specific additional obligation that the utility faces—or utilities face—to procure a minimum share of solar power specifically instead of just renewable energy more generically. These kinds of targets or these kinds of quota obligations are obviously a form of market intervention in that the government is saying, "Utilities operating in this given area need to procure a minimum share of renewables." So, there's no question there's a market intervention there. Where the subsidy piece comes in is with the use of—or the reliance upon—renewable energy certificates, which can typically be traded between different legally obligated entities.

So, renewable energy certificates—as we see here in the next slide; our number 10 on a list of solar subsidies—are often used in combination with quota obligations, and they represent 1 megawatt hour of renewable electricity that can be sold separately from the electricity itself in order to meet a given obligation. So, in other words, a producer—let's say a solar producer—can sell their solar power either under a contract to the utility or on the wholesale market, and they can then also sell this second product—namely, the renewable energy certificate—which also has a trade-able value, because utilities have an obligation to meet, and they can meet that minimum solar obligation either by producing solar power themselves, buying solar power—solar electricity from someone else—or by purchasing RECs. And, as a result of that obligation, as a result of that overall regulatory framework, the renewable energy certificates have a value and can be bought and traded separately from the electricity. This means that if you're a solar producer, again, you're getting two revenue streams. You can sell the electricity at a given price and you can sell the solar REC at a given price to improve your overall cash flows.

Now, in many jurisdictions, it's not just a REC or renewable energy certificate. Governments have differentiated them further and created what are called SRECs or Solar Renewable Energy Certificates that typically trade at a higher value than generic renewable energy certificates in the market. And I've included a few examples here of some US states with specific SREC policies, in case you're interested in having a closer look.

And now, a final item on our list of solar subsidies is what I've called here "Financial De-risking Mechanisms". Now, this is a fairly broad category and a bit amorphous because it takes a number of different forms. It's also related to our low interest loans example from earlier that captures aspects or elements like, partial risk guarantees, currency protections or currency risk hedging instruments, off-taker risk guarantees, sovereign risk guarantees where the government itself steps in or someone steps in on behalf of the government if there's a solvency concern to essentially support the contract and provide banks and lenders, in particular, the security that the project will receive the cash flows it's been promised based on its output, and political risk guarantees, among others. So, there's a whole bunch of different forms of guarantees and risk off-setting mechanisms that aim to de-risk the overall investment environment and thereby, help unlock financing. These different instruments have a cost.

They are a form of support that's often offered by governments themselves or by multi-lateral agencies like the World Bank, the IFC, MIGA, which I've listed here at the bottom—and you can find out more information about that. These are different kinds of public or quasi-public or multilateral type entities that support financial de-risking in a range of different ways, and often targeting specifically certain technologies. So, hydropower often qualifies for these kinds of financial de-risking measures as well, as do gas plants, in many countries, as do wind and solar power projects in different countries. That said, these do remain a form of subsidy, a form of special treatment for solar power, and in many markets, these kinds of tools, these kinds of interventions, have proved really important to unlocking financing and getting initial projects off the ground in countries where there were no large-scale solar projects before. So, I've provided a few examples here; there are many others—Zambia, Namibia, certain guarantees in India.

There are also recently projects in Senegal and elsewhere that have made use of similar kinds of guarantees. These remain very much a part of the renewable energy policy toolkit and continue to be used in markets around the world. Now, I've tried to summarize all of these in a few tables 'cause I realized that's an overview of 11 different major solar subsidy types, and I've summarized them here. I'll just go over these quickly again just to give you a sense and a recap. If there are any subsidies that you can think of that don't fit neatly into any of these categories, I would love to hear from you.

So, if you can please follow-up and send me a quick e-mail, I'll just recite my e-mail address here—Toby—T-O-B-Y—@e3analytics.eu. I'd love to add these to the list. If there are any that don't fit into this, please do feel free to follow-up and we'd love to discuss further. Based on the history of solar subsidies, this list of 11 different subsidy categories is designed to capture the majority of the universe of solar power subsidies that are out there in the world today. And, as we discussed previously, in some cases, there is still debate around whether one or another is a subsidy in the classic sense of the term or whether it's simply a public—a government intervention or simply a part of the overall market design or a part of the overall policy and regulatory environment that may not really be a subsidy; just a form of market regulation.

And again, there's clearly a gray area and there is no right or wrong answer. The question really comes down to a debate around the meaning of "subsidy" and what constitutes a subsidy and what does not. So, with that, some concluding remarks. The debate around solar subsidies remains a very real part of the solar industry worldwide, as you no doubt have seen and heard from different newspaper articles and radio interviews and other Twitter debates, for instance, on the internet, and it remains a really key part of the debate around the future of solar power worldwide. However, it's also becoming increasingly clear that as solar becomes increasingly cheap, it eliminates, arguably, the need for traditional subsidies—these classic subsidies like grants and rebates.

Now, as we saw, there still are governments like the US and France that continue, among others, that continue to use these kinds of traditional subsidies, but broadly speaking, it would appear to be the case that those kinds of explicit traditional government subsidies are starting to become less common and governments are moving more and more in favor of other instruments or simply, framework conditions to support and allow investment in solar power. And we'll get into that in a moment a little bit more. Also, major governments like China—which, up until last year, represents around half of the global solar market—have recently phased out feed-in tariffs and are moving now to auctions in an attempt to lock in even lower prices for solar power. Now, in a case like China and in other markets around the world that have moved to auctions, that is one way of getting away from this whole debate around subsidies, because, as the argument goes, when the market sets the price—for example, via an auction that involves market competition between different companies—most would agree that the resulting price is not a subsidy. The resulting price is what the market price of solar power is.

And for governments that are concerned around public subsidies and around criticisms of misspending public funds or around artificially increasing electricity prices, auctions are one way to simply say, "This is the market price and therefore, there is no subsidy involved." However, it remains the case that many auctions around the world include other forms of subsidies that are separate from the auction price. For example—free grid connection. In many cases, there's subsidized land or even free land for the construction of solar power projects. There's also preferential tax treatment that may be part of the overall auction that may be awarded to the auction winner.

So, even if the price was competitively derived, that doesn't necessarily mean that the project is fully subsidy free. So, again, the debate there arguably rages on. Now, the purists and many economists would argue that all projects in the future should simply sell their electricity onto the spot market. Spot market is the leading mechanism for allocating electricity based on supply and demand and price factors, and all suppliers should simply sell to the spot market, receive the price that the spot market provides, and that would be a fully unsubsidized electricity industry—or at least in theory. Now, one of the difficulties with that is that it's difficult, if not impossible, to account for historic subsidies that may or may not have been provided, for example, to coal mining or coal fired power plants during the investment phase, to nuclear power plants that are on the grid and selling into that spot market.

Those kinds of market distortions are baked in to the electricity market and therefore, it's not fully an apples to apples comparison because new solar projects that are being built today would have to compete against these largely amortized—and often, previously subsidized—power plants. So, there's never a truly even playing field in any given spot market around the world, because you have a mix of different electricity generating assets that are competing with each other that are at different levels of amortization, that have benefited from different kinds of regulatory and market conditions in order to be invested in and have often benefited from one form of government subsidy or another. So, the idea—the long-awaited dream of a fully

unsubsidized energy market—still seems a long way off due to these historic distortions, historic realities that have shaped the history of the power sector. Another issue here is by forcing all projects to sell their power on the spot market—which is what many are arguing, including many folks at the European Commission here in Europe; that projects should just sell on the spot market and we should abandon the use of contracts altogether. One risk here is that this increases the cost of finance, which, in turn, pushes up the cost of solar.

So, by forcing projects to all operate on the spot market and not receive any kind of contract or not qualify for any kind of long-term contract—be it 5 years, 10 years, or even 20 years—this pushes up the cost of financing, because this makes investments like solar riskier. And by making investments like solar riskier, you increase the cost of capital, which, again, makes the overall cost of solar go up. So, there's a tension here—there's a tradeoff here—at the heart of this debate between the desire to remove all kinds of policy intervention and, what I've called your "policy induced cost increases". If policy dictates that all projects have to sell on the spot market and not benefit from any kind of off-taker, any kind of contract, then, you effectively increase the cost of everything on the system, which is arguably a perverse consequence of wanting to avoid subsidies because it actually pushes costs for rate payers and businesses up in the process by effectively introducing more artificial risk into the equation. Now, again, the debate would be whether the additional allocative efficiency gains from having more producers selling onto the spot market would actually offset some of those additional rate payer costs, but it remains the case that financing risks—in particular, financing costs—remain a very critical part of determining, overall, electricity generation costs for most technologies and any policy change that significantly increases financing costs is, therefore, arguably, a way of artificially increasing electricity costs in, in fact, a negative subsidy—in other words, a forced cost increase.

And there's an important debate to be had there around how to balance this tradeoff. Now, regardless of what type of policy support is offered to solar power in a given jurisdiction around the world, the role of the overall framework conditions is likely to remain important. In other words, it's important to have clear rules governing access to the grid, who can connect to the grid under what conditions. It's important to have streamline permitting so that projects don't suffer unnecessary delays due to permitting issues. It's important to have long-term targets that provide some degree of clarity over the future evolution of the power mix—particularly in light of the fact that most of the energy system does not yet internalize its cost.

And in light of climate change and a number of other global concerns, the role of long-term targets is likely to become even more important and remain, as a result, a part of these overall—what I'm referring to here as the overall framework conditions. So, even if there's no explicit subsidy anymore, even if there's no rebate or no tax incentive or no preferential VAT treatment, those kinds of framework provisions are still really important to making investment happen and the need for that is not likely to go away. In other words, even

$0.02 solar needs a clear regulatory and permitting environment, and that's why many argue that although we're gradually moving away from subsidies in the solar sector, we're moving increasingly—a number of jurisdictions are moving towards competitive auctions and solar is able to compete now on price in virtually every electricity market in the world. The need for subsidies clearly fades away over time. However, the need for a clear regulatory and permitting environment and an overall financing environment does not.

And I think that's really one of the core issues at the heart of this debate and hopefully, with the context you now have and the overview of solar subsidies that we've seen, you're in a better position to understand the nuances of this debate and understand a little bit more what is meant by solar subsidies and also, what some of the tradeoffs and issues at the heart of this debate are. Thank you very much for your attention. I provided here some further—a few examples, a few reports, some further reading. One key report that I had the pleasure to be a part of for the IEA-RETD on transitioning to policy frameworks for cost competitive renewables. One of the charts from earlier in the presentation was taken from that report; a recent report on renewable policies in a time of transition from IRENA, REN21, and the IEA; an analysis of subsidies for the G20 as well as a recent article from The Economist that really puts the question quite bluntly, "Can the solar industry survive without subsidies?"

And I provided a link to some of those food for thought. Again, this remains a very vital and important debate and it's been a pleasure to present on this and try to provide a little bit more clarity into this particular issue. I'd like to thank the International Solar Alliance as well as the Clean Energy Solutions Center for supporting this training series. I'm Toby Couture, on behalf of E3 Analytics, and it's been a pleasure to be with you today. Now, we'll shift to the knowledge checkpoint where you'll have a few questions based on the presentation just to test your knowledge, and I look forward to being with you on the next CESC and International Solar Alliance training series. Thank you very much and have a great day.