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The Future of Feed-In Tariffs

—Transcript of a webinar offered by the Clean Energy Solutions Center on 10 June 2014—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Presenter

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Sean Esterly — Hello everyone, I'm Sean Esterly with the National Renewable Energy Laboratory and welcome to today's webinar which is hosted by the Clean Energy Solutions Center in partnership with E3 Analytics. In today's webinar, we'll discuss the future of Feed-In Tariffs. One important note of mention before we begin our presentations is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center's resource library as one of many best practices resources reviewed and selected by technical experts.

And before we begin, I'll go over a couple of the webinar features. You have two options for audio today. You may either listen through your computer or over your telephone, and if you choose to listen through your computer, please select the mic and speakers option in the audio pane to eliminate any chance of echo or feedback, and if you dial in by phone, just select the telephone option and a box on the right side will display the number and also the audio PIN that you should enter to dial in. And panelists, we just ask that you mute your audio device while you are not presenting, and if anyone is having difficulty with the webinar, you may contact the GoToWebinar's help desk number at the number at the bottom of the slide. That number is 888-259-3826. And we encourage anyone from the audience to ask a question at any point during the webinar. The way you ask a question during the Clean Energy Solutions Center webinar is to submit it through the question pane, so you type that in and I will receive those and present them to our presenter or our panelists today during the question and answer session. If anyone is having difficulty

viewing the material, the presentation material, you can find PDF copies of the presentations at cleanenergysolutions.org/training and you can follow along as our speaker presents. Also, we do post an audio recording of the presentations to that site and we will also be adding to the Solutions Center YouTube channel where you will find other informative webinars as well as video interviews with thought leaders on clean energy policy topics.

Today's webinar agenda is centered around the presentation from our guest panelist, Mr. Toby Couture and Mr. Couture has been kind enough to join us to provide a global perspective on the future of feed-in tariffs by evaluating different arguments on the future of feed-in tariffs, and this webinar will reflect on what changes the feed-in tariffs could mean for the renewable energy industry and what implications they could have for assisting in the flow of finance to the sector worldwide. And before Toby begins his presentations, I'll provide a short informative overview of the Clean Energy Solutions Center Initiative and then following the presentations, we'll have a question and answer session where Toby will address questions submitted by the audience and then some closing remarks and a brief survey.

This slide provides a bit of background in terms of how the Solutions Center came to be formed, and the Solutions Center is one of 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011 and is primarily led by Australia, the United States, and other CEM partners. Outcomes of this unique initiative includes support of developing countries and emerging economies through enhancement of resources on policies relating to energy access, no cost expert policy assistance and peer-to-peer learning and training tools such as the webinar you are attending today. And there's four primary goals for the Solutions Center. First goal is to serve as a clearinghouse of clean energy policy resources. Second is to share policy best practices data and analysis tools specific to clean energy policies and programs. And third is to deliver dynamic services that enable expert assistance, learning, and peer to peer sharing of experiences. And then lastly the center fosters dialogue on emerging policy issues in innovation around the globe. And our primary audience for the Solutions Center is energy policy makers and analysts from governments and technical organizations in all countries. We also strive to engage with the private sector, NGO's, and civil society.

One of the marquee features that the Solutions Center provides is a no-cost Expert Policy Assistance know as Ask an Expert, and Ask an Expert program has established a broad team of over thirty experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost. So for example, today's speaker, Toby Couture, actually also serves as the Solutions Center expert on finance and markets, so if you do have a need for policy assistance in finance and markets or any other Clean Energy sector, we do encourage you to use this valuable service. Again, it is provided to you free of charge. So if you request

assistance, you may submit your request by registering through our "Ask an Expert" feature at cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations. So in summary, we encourage you to explore and take advantage of the Solutions Center resources and services including the expert policy assistance, the database of Clean Energy Policy resources, subscribe to the Clean Energy Solutions Center newsletter and participate in webinars like this.

And now I'd like to provide a brief introduction for today's panelist. And today's presentation will be delivered by Toby Couture, the founder and director of E3 Analytics, an international renewable energy consultancy based in Berlin, Germany, and Toby works in a wide range of topics in renewable energy including policy and regulatory analysis, market research, strategy consulting and finance. And now with that introduction, I'd like to welcome Toby to today's webinar. Welcome Toby.

Toby Couture

Thanks Sean. It's great to be here and thanks for that introduction. So as you can see the topic today is the future of feed-in tariffs. There's been an active debate around the world, around where feed-in tariffs are going as Germany has started to modify its policy framework, and I think a lot of governments around the world have looked at Germany as a leader in renewable energy policy and a leader in – particularly in feed-in tariffs around the world, and I think the sudden shift here over the last year or two in the German discussion has really led to a lot of questions around the world, so the goal today is to try to provide a bit of context for that to analyze some of the arguments for and against and ultimately to help other decision makers and policy makers around the world to sort of work their way through these topics and questions to arrive at better solutions for them and their own individual countries. So if we – we're going to start here. The outline of the presentation is broken into four broad parts and each section will cover 5 to 10 slides on each of the topics, so we'll kick off with the first one, which is defining feed-in tariffs.

So feed-in tariffs typically involve three basic components. A long-term contract, which ranges typically from 10 to 25 years depending on the country and on the electricity market. A fixed purchase price over that period of time, sometimes with inflation indexation, and a third, which is guaranteed grid access which enables any eligible power producer to connect to the grid and sell their power. Typically the purchase prices are actually based on analysis of the cost of generation from different renewable energy sources, so you have a different price for wind, a different price for solar, a different price for bioenergy sources, biogas, as well as for geothermal and different renewable energy technologies. We're also seeing tariffs being offered to new and emerging technologies like wave power and tidal power in some jurisdictions around the world. FITs also include a number of related provisions that tie into the local electricity market structure and the regulatory environment. Those can include things like priority dispatch rules, which allow renewable energy to be

dispatched first in the merit order. This is now the law across the European Union and is being adopted in other countries primarily to avoid curtailment of renewable power and to increase investment security.

Other components include things like grid codes as I mentioned inflation indexation. In many cases, a growing number of policies are being adapted to include degression, which is a way to track and encourage technological change in renewable energy technologies. So the percent – this results in a percent per year decline in renewable energy purchase prices, so new contracts in subsequent years get offered a lower price than projects in previous years to track the evolution of cost in each technology category. And finally, most feed-in tariffs around the world include caps either on project size or on the total volume of projects allowed.

Now taking a step back, it's important to recognize that as Winston Churchill once said, however brilliant the strategy, you really do need to occasionally look at the results, and I think one of the things that you see when you do look globally is the results have been comparatively good. There have been some problems in key markets like Spain as we'll discuss a little bit further and in certain markets like the Czech Republic but broadly FITs have demonstrated a fairly high level of success and impact in renewable energy markets and arguably have actually defined a policy space globally in renewable energy markets. Recent analysis suggests that they're responsible for approximately 50 percent of global wind power and about 75 percent of global PV development around the world, and if you add all renewable technologies, we're somewhere around 75 percent of global investment is attributable or has occurred within markets that have feed-in tariffs. Two of the fastest growing markets today are Japan and China and both of which are currently founded on FITs and are now representing the lion's share of the renewable energy market in certain technologies, particularly in PV.

So this is a quick overview that's from the most recently launched REN21 report on renewable energy update around – providing a renewable energy update around the world and you can see the evolution of the different policy mechanisms. For much of the last 4 or 5 years, feed-in tariffs have clearly been the dominant, in fact going back to even the early 2000s, feed-in tariffs have been the dominant policy mechanism around the world. Now that is starting to change. You see a slight reduction between 2012 and '14 in the total number of policies and a significant rise in both net metering policies as well as fuel mandates for biofuels in the transport sector and a pretty steady rise also in tendering or what are also called renewable energy auctions [ph] or reverse auctions.

So why has the market changed? Or why have feed-in tariffs been as popular as they have been around the world? First, they've provided open access. They've lowered the barriers to entry for a wide range of different renewable energy investors whether homeowners, farmers, cooperatives, churches, different associations as well as investors and utilities. So in that

way it's diversified the supply base, the number of different suppliers in the market who can produce electricity. For historical context, if you look back over the last 100 years, the electricity industry has been largely dominated by a few large actors either private utilities or government owned utilities and that's still the case in many countries.

What feed-in tariffs have triggered perhaps more than anything else is a significant decentralization in the actor base, the number of investors and actors who can actually connect to the grid and produce power. So this has led to a wide range of different impacts as well as what has been called a democratization of the electricity supply, and some argue that ultimately this makes sense because renewable energy is highly, itself highly distributed and because the resource is distributed, there is, therefore, an argument that the investment in it should also be distributed across the landscape and across different communities. And you can see here a quick chart on the breakdown in Germany in 2012, so you can see the significant role, almost 50 percent of projects are owned either directly by citizens or cooperatives on a capacity basis. So you can see a fairly significant role also for institutional and strategic investors and a comparatively smaller role for traditional utilities or energy suppliers. The second key argument or key reason for their popularity is that they reduce investment risks. This has really been one of the most important features of feed-in tariffs as they've been successful in de-risking the investment environment, and by reducing a host of different risks, they've actually reduced the cost of capital which makes renewable energy in the individual jurisdiction cheaper. It's quite common here in Germany for renewable energy projects, particularly solar for example, to be financed for less than 5 percent cost of capital. Now that translates directly into a lower cost of generation because the cost of capital is one of the major determinants of the cost of electricity. So lower cost finance has been a really powerful driver of some of the market growth that we've seen in markets like Germany.

Shifting to the third, FITs have also helped provide greater transparency in the marketplace. They post open access prices to which anybody can respond in principle. Sometimes there are eligibility requirements but broadly, anybody can participate in most markets in supplying power and selling it to the grid. Another dimension of this is that the contract terms are public, so there's no backroom deals, no preferential treatment. Everybody gets the same standard contract terms and that's a powerful plus for transparency. And the fourth point is that they've been considered by some more efficient to administer, so because renewable energy projects are often smaller in size, it can be difficult or time consuming to negotiate every individual contract, so if you imagine the over one million contracts that have been signed in the solar PV market in Germany alone, to administer each of those and to sign an individual price for each of those contracts would have been an incredibly time consuming exercise.

So policy makers have found that it may be more efficient to issue contracts on a standardized term – on what's called a standard offer basis. So that way you can design one standard contract and issue it to a wide range of investors in individual technology categories and that arguably makes it more efficient to administer the policy as a whole. So those are the four key arguments – there are certainly other arguments to be listed but those are four of the key arguments that we focus on today.

Now shifting to the second part of the presentation going back to the original – the kickoff of the presentation. Are feed-in tariffs on the decline? So we're going to look here at the case for and against. So first, the case against. Critics of feed-in tariffs have argued that the payments, the actual FIT prices, have been unsustainably high and they have often failed to track changing technology costs. This is particularly the case in solar PV where the cost declines have been more rapid than even the most optimistic analysts and commentators thought possible. So we've seen a very significant reduction in solar PV costs as the markets have scaled and this has made it very difficult for fixed price feed-in tariffs to track that rapid cost evolution, so in some cases, it's resulted in excess profits for investors and many have argued an unsustainable burden on rate fares. So that's sort of the first main line of criticism. The second is that FITs have encouraged costlier technologies rather than the least cost option. Many renewable energy tenders or auctions around the world tend to focus on the lowest cost technology, so they're what's called technology neutral. You issue an open tender for electricity supply and whichever technology is the most competitive will tend to win that tender.

Now there's a debate to be had about whether that actually is technology neutral or not, but the argument has been that the least cost technology should be chosen first and that would be more economically efficient. So critics have argued that because feed-in tariffs offer different prices for different technologies, some of them significantly higher than others, that this has been inefficient economically and that we should only encourage the cheapest technologies. So that's the second main line of argument. The third is that FITs have lacked adequate controls on market growth. So the lack of proper caps and administration and monitoring has led to some boom and bust cycles in certain markets, most notably, as I mentioned previously, in Spain and the Czech Republic and some have even argued that this has been the case in Germany. Now this has exacerbated instability in the market and underscored FITs arguably their unsustainability, so critics have argued that feed-in tariffs have in some cases been so successful that they have themselves been the source of instability in the market. So that's a bit of a different tack but one that I think does get to the heart of some of the challenges that have occurred in markets like Spain and the Czech Republic and it's one of the major criticisms, one of the major arguments that policy makers around the world are having to take into consideration in designing their own frameworks.

The fourth and final argument is that FITs are fundamentally incompatible with wholesale electricity spot markets. Now this argument typically comes more from people who work in the electricity trading industry or from economists who focus on the dynamics of wholesale spot markets, and the argument is fundamentally that fixed price contracts with a purchase guarantee removes the incentives for producers to respond to what's happening in the market place and because you have all these different producers who have a per kilowatt hour – who receive a per kilowatt hour price for every kilowatt of energy – of electricity produced that they have no incentive to limit their output when there's potentially oversupply in the market, and when there's oversupply in the electricity market as we've seen in certain cases across Europe, this can lead to negative prices and negative prices are a significant issue that system operators and broadly even distribution on some level – distribution operators are having to deal with and try to mitigate. So some have argued that we need new policy frameworks, new policy mechanisms to avoid some of these incompatibilities with wholesale electricity markets. This has led to some – a move notably here in Germany but also in markets like Spain towards premium feed-in tariffs, so instead of a fixed price, a premium on top of wholesale prices is offered so that your actual payment fluctuates over time. We'll get to that a little bit further in the presentation. So those are the four major arguments against.

Now we're going to shift into the arguments for or in favor of FITs. The why have FITs been successful? First, FITs have provided fundamentally what investors need. Some have argued that because they provide long-term contracts, a cost based price, in other words a price that allows you to recover your investment, and a nondiscriminatory approach to grid access, they have fundamentally provided – it's ticked the major boxes that investors need in order to make that decision, and by making it more investor friendly, making the policy environment more investor friendly, FITs have helped attract investment. This is what Deutsche Bank memorably referred to as TLC. Feed-in tariffs have provided transparency, longevity, and certainty in the marketplace. So that's the first major argument in favor. The second is that FITs have helped achieve what deregulation or what is sometimes called liberalization here in Europe could not have achieved alone. It's introduced a greater diversity of actors. It's helped break up traditional monopoly suppliers, and it's helped democratize the electricity system.

Now when individual homeowners or farmers or residents in rural communities can produce their own power and sell it to the grid, you get a decentralization in the marketplace that can be quite powerful and can have quite significant consequences for the way electricity markets work and also for the way that electricity supply is coordinated across a geographic region and that decentralization has led to some fairly significant structural changes in the major markets where it's been – where they've been most successful. The third is that FITs have actually

been a major driver of cost reduction in renewable energy costs. We've seen this most notably in solar PV. Everybody's seen the charts that show over the last 5 or 6 years of the last decade the significant cost reductions that have occurred in solar PV particularly. Now the argument previously that renewable energy policy should be technology neutral or should only focus on the least cost technology would have had as a consequence that solar PV would have never had an opportunity to reach market scale and, therefore, would have likely never underwent the kind of cost reduction that it has seen in the market in recent years, so proponents or people who supported feed-in tariffs have argued that this ability to drive down costs is one of the major advantages of feed-in tariffs because they allow markets to scale, they create an integrated supply chain of different producers and suppliers and marketers and salespeople and installers who are instrumental in squeezing out the soft costs in the equation and making it more affordable, making it more attractive for individual investors within that marketplace. This is what is sometimes called in the European context, dynamic efficiency, that feed-in tariffs have helped drive costs down dynamically over time by focusing not only on the cheapest technology but also on some of the more expensive ones. So that's been another – a third major argument in favor. Shifting to the fourth. Some have argued that feed-in tariffs are necessary for renewable energy markets to scale at all to get to significant gigawatts scale deployment annually in the marketplace. Because they provide open access to anybody who wants to invest, they help scale up the renewable energy market in a way that would simply not be possible under tenders which are often volume restricted bilateral contracts which require direct negotiation one contract at a time, net metering which is focused mostly on small systems, tax incentives which have their own restrictions and drawbacks, or certificate markets which introduce significantly more price risks and market risks into the equation.

So FITs have – proponents have argued is more successful at providing the necessary conditions that are required in order for markets to really scale up by being open access, by providing a clear price, and by enabling all of those financial boxes to be ticked to allow investors – to attract investors to the marketplace. So those are the four essentially broadly laid out the main case for and the main cases against. So now, we're going to shift into a bit more of a discussion into – regarding feed-in tariffs and renewable energy finance. So how does this all connect to where investors look at this? How investors look at this?

So one of my arguments in these next few slides is that globally both in Europe and U.S. across the world we have spent far too much time looking at renewable energy policy through the lens of economics rather than looking at it through the lens of finance. And I think there's a lot to be gained by taking a more finance driven approach, and I'll try to lay out why that's important in the slides ahead. So I ran a financial – a quick financial model in a market with a good solar resource, a typical 20

megawatt solar project, and if you can reduce your cost of capital to somewhere in the 7 percent range, you get a levelized cost of electricity generation, an LCOE, of somewhere just short of 11 U.S. cents per kilowatt hour in a relatively sunny market at today's solar prices. If you double that cost of capital, you just simply double the cost of investment, the cost of capital required to finance that project, you have an approximately 50 percent increase in the LCOE. You can see with this simple example the dramatic impact that the cost of finance has on the LCOE of renewable energy projects. One of the fundamental reasons for this is that renewable energy projects are capital intensive and that's something we'll get back to in some of the slides to follow. But you can see that if policy makers can find ways of squeezing the risks out of the market and reducing that cost of capital, they can, therefore, reduce the ultimate purchase price, the ultimate feed-in tariffs price that they have to pay to investors in the marketplace.

So taking a look at risk a little more closely. Risk has a negative impact on finance in two key ways. There are multiple ways – I focus here on two. On the one hand, they increase the cost of both debt and equity. So banks looking at it are going to require a higher interest rate on commercial debt or on their bank debt, and equity investors are going to price in all those additional risks and are going to require a higher equity return on investment. Both of those things increase the final cost of capital what is sometimes call the WACC, the weighted average cost of capital. The second key way that risk negatively impacts finance is that it makes the capital structure more equity heavy. In other words, there's a larger share of equity in relation to debt. Now in Germany it's quite common for projects to be financed at – with only say in the 10 percent range equity down, so you have a 10 to 90 structure whereas in emerging markets and some markets in Africa and some markets in Southeast Asia, the ratios are significantly more skewed in favor of equity so you have something in the 70/30 range or in the 65/35 and in some cases it's even in the 50/50 range for equity to debt ratio. So in those sorts of circumstances because your equity is a more expensive component, if the capital structure is more equity heavy, that results in a higher cost of capital which negatively impacts the finance ability and negatively impacts ultimately the price required to make that investment attractive. You can see this in a stylized form in a recent report that was published by UNDP called Derisking Renewable Energy Investment and they lay out a number of different cases – through case studies from around the world looking at the impact of derisking on the cost of finance, and you can see here from left to right the impact of reducing various risks in the environment.

So power market risk, the permitting risk, resource and technology risk, grid connection and transmission risk, counterparty risk, all of these different risks have essentially a cost attached, and if you can reduce those through a better policy environment, you can reduce the ultimate cost of capital required to get projects financed. And this gives you an idea of

what that looks like. So why does this matter? Why does risk and finance matter? Well, if we look ahead charting our way to a lower carbon future is fundamentally going to require abundant low cost capital. We're going to need lots – we're going to need billions if not trillions of dollars of capital investment on an annual basis to get us to where we need to go globally in terms of a decarbonized electricity mix as well as an increasingly carbon light transportation and heating and cooling mix. So there are significant challenges ahead and in order to solve those challenges we will need finance. We will need access to capital, and if we can reduce the cost of that capital being deployed in the market, we can play a significant role in reducing the social burden or the social cost of that investment, that asset investment that ultimately needs to take place for us to get to a lower carbon future, and in the renewable electricity space, feed-in tariffs have been a key part of making that possible. Now FITs aren't obviously going to solve all the challenges in the transportation sector, aren't going to be useful in some cases for the heating and cooling sector where it's more case by case, but there have been steps towards introducing mechanisms similar to that in the heating and cooling market such as in the United Kingdom. So FITs have been a key part in many markets of making that capital available at a low cost and at scale.

So with all of that said, what's the future? And the question that many policy makers continue to ask – I travel quite a bit in recent years working with policy makers on some of the challenges they're facing and trying to help them design more successful frameworks to attract investment and to stabilize – introduce stability into the renewable energy finance market, and the question that often comes up or that's been coming up increasingly is well, if they've been so successful, then why is the leading proponent or the leading – the paradigm example of FIT deployment fazing them out? So what is happening here in Germany? Now during the question and answer, I'm glad to take a little bit more time to dive into this and to answer some questions around what is happening and I'll do my best to provide a bit more insight than I have in the slides here, but the consensus – I shouldn't say consensus because there isn't a perfect consensus in Germany at this stage, but leading opinion makers seem to be arguing that FITs may have been a powerful policy tool to help Germany reach the first 25 percent of renewable energy in the mix, but beyond that, Germany is going to need alternative mechanisms in order to avoid issues like negative prices as mentioned earlier and in order to encourage greater market integration. In other words, to integrate renewable energy into competitive dynamic electricity spot markets. So even some of the organizations and some of the agencies that have been quite supportive of the renewable energy sources act here in Germany have started to argue that well, maybe we do need a change, maybe we need to adjust and adapt the policy. In fact, the policy has itself already been adapted considerably in this direction so the feed-in tariff is currently in place in Germany is in many respects quite different than the feed-in tariff that it had even 2 or 3

years ago with the move to premium based remuneration in particular being one of the major differences but also a shift towards requiring more responsibility on generators in the marketplace, more responsibility for avoiding issues like negative prices for marketing their own power for example within the marketplace. So those are some of the arguments that some of the leading opinion makers in Germany are advancing for why that policy shift is necessary.

One of the challenges with this, however, is that it assumes that all renewable energy technologies or all technologies, not only renewable, should eventually be financed by the spot market and this is what I've referred to as being similar to herding cats and you can see here with the little cartoon that all renewable technologies have been sort of corralled into trying to get them into an environment where everyone's competing, apples to apples, within wholesale spot markets. But one of the truths, one of the facts of the market here in Germany and this has been part of public statements by some of the CEOs of the largest utilities in Germany as well as beyond in the rest of Europe is that no technologies, not even conventional, not even gas, not coal, not nuclear, nothing is financeable currently by the spot market. So the spot market is no longer – is not a mechanism that has helped – that is sufficient currently to attract investment to the marketplace and get people to actually put capital at risk in financing specific assets regardless of the technology and we can see part of why. So if we look at what's happening currently, this is a chart that provides sort of almost 10-year view of day ahead maximum and minimum prices in the German electricity market. And you can see during the 2006 – '07 period very significant price spikes when natural gas prices went up very high and the volatility was quite high until about 2009. Things have started to really lessen and you can see the impact broadly the trajectory is electricity prices have become less volatile and have become lower on average over time as renewable energy has grown in market share but the volatility remains a key factor and a key concern of investors. You can see the power mix here on an annual basis for 2013 sketched out by month.

This is from the Fraunhofer Institute that produce regular data on providing market updates. The link is there below if you're interested in more charts like this and more fine grained analysis. But you can see here that the different technologies in the marketplace play out differently, so PV is primarily playing out during the summer months and you can see the impacts and the correlation with a reduction in wholesale market prices when PV production is at its peak. So if you look at the May, June, July timeframe, you see significant drops in the day ahead and intraday prices as solar comes onto the market during the daytime, so that curve plays out and you can see the impacts that renewable energy has had on market prices. Here's another one that provides a weekly snapshot. So the previous slide was on an annual basis. This slide provides a snapshot of a typical week in the summer in Germany, so I've chosen here in the month

of July and you can see again the same pattern with PV representing a significant piece of the daytime supply market, in some cases over 40 percent of supply in some moments is produced by PV alone and again the same price suppressing effect.

Another interesting thing worth noting is that the dynamics here are complimentary in some ways with wind power but wind power in months where it's windier has played a smoothing effect and you can see this both from the annual charts before as well as in some of the daily and weekly charts provided by Fraunhofer. Now what does this mean? Some key developments in the last year is that market prices in Germany in the first quarter have averaged 33 euro per megawatt hour. This is almost 10 megawatts lower than in the first quarter last year and that's meant that a lot of the conventional producers, a lot of large utilities in the marketplace have been below the price they need to actually make a return on their investment, to run their conventional power plants. So many conventional power plants that have to rely on the spot market are currently not profitable and that's one of the major reasons why gas plants across Germany have been mothballed. They simply are not profitable in today's electricity market environment. The only plants that are able to either are relying partly on bilateral contracts or are significantly lower in their operating costs and capital costs than their competitors.

So what this means for utilities, you see here the two examples I've chosen from E.On and RWE. E.On has posted a 12 percent decline in earnings in 2014 while RWE has posted a 15.5 percent decline as well as its first loss in the company's 60-year history. Now these low wholesale market prices as I've highlighted before have made it effectively impossible for any new power plants to be financed solely by the spot market and it significantly impacted both gas plants as well as other conventional more carbon intensive plants like coal. The deeper challenge here is that spot markets are based on an energy only concept, so the – I could get into this in a little bit more through the questions, but spot markets can be quite powerful tools for allocating supply because they create a price that allows electricity to be traded between 2 different parts or 2 different parties. In some cases that can be over national borders between France and Germany, between Germany and Switzerland, and in some cases that can be between different actors in the market. So spot markets are very powerful and very useful as an allocation tool; however, as I pointed out, they are now an insufficient basis on which to finance new supply because the prices are on the one hand too volatile and on the second too low to enable new assets in the marketplace to be financed, and reconciling these 2 challenges, these 2 realities, I would argue is one of the key challenges ahead both for Germany as well as for other markets around the world that are going to move to higher shares of renewable energy in the mix.

So if this herding cats approach is to shift all electricity producers into the same wholesale price market environment, the result is likely to be a

complete stop in the flow of finance to the electricity supply industry. A full stop because projects are simply not financeable in that environment today and that is a profound reality that policy makers and people who work in electricity markets are having to deal with today is how to maintain finance ability in such a critical sector particularly at a point in time when we need to make the kind of transition that we do in de-carbonization in the years ahead. So these are some of the challenges that German policy makers are grappling with and are having to respond to. As I pointed out earlier, renewable energy technologies are capital intensive. If you look on the left side, you can see some of the least capital-intensive technologies. As we move further to the right, you see increasingly less capital-intensive technologies. Now with the exception of biogas and biomass, renewable technologies like hydro, wind, and PV have very low fixed costs – very low variable costs and very, very high fixed costs. This means that if you're going to finance those assets, you need some degree of certainty over your future cash flows, and if you don't have that, it increases the risk of investment and it makes investment harder to find because there are fewer investors in the world who are prepared to finance those kinds of projects with that much price risk. So what feed-in tariffs in the past have helped do is reduce that price risk, reduce the market risk by providing a fixed price for those capital-intensive assets to be financeable and that's partly what is no longer possible under the move to wholesale spot market prices alone.

Now this isn't only the case in electricity markets. We see the use of long-term contracts. In fact, they were a traditional part of the electricity industry for decades before electricity deregulation and they continue to be used in many markets around the world including in China, in many parts of Africa as well as in Latin America. They are also used to finance things like airports and roads. In some cases, they're even used to finance buildings. A variety of different infrastructure projects that are highly capital intensive, a long-term contract is offered that helps reduce the risk of investment and that also helps reduce the cost of capital required to finance that investment as we saw earlier. So as long as renewable energy technologies remain highly capital intensive as seen in the previous slide, they will be most easily financed, most effectively financed using some form of long-term contract. Long-term may no longer mean 25 years. It may mean something more like 10 to 15 years depending on the different market environment but some sort of long-term off take agreement is likely to remain a successful component of – an important component to a successful renewable energy policy regardless of whether it's feed-in tariffs or you do it via bilateral contracts or you use traditional tendering mechanisms.

Ultimately, each of those different policy mechanisms can result in a long-term contract. The policy debate then becomes one about how renewable energy contracts are allocated. As I mentioned with bilateral contracts, you have a one to one negotiation between two different parties. Under

traditional tendering or auctions, you issue a block of capacity and you allow bidders to bid for that but it tends to favor the larger players in the market and tends to include more risks because you're not sure whether you're going to get a contract or you can make the contracts available to a wide range of investors and effectively to anybody on a standard offer basis. So the policy debate is more of about – is becoming more about how renewable energy contracts are allocated rather than about the specific need of a long-term contract or not. Now in some cases we're moving away from that as I mentioned in the European context but fundamentally the debate has shifted significantly from where it was even a few years ago, and I'm glad to get into that a little bit more in the Q&A sessions.

Now if you recall the fourth argument against feed-in tariffs it's often raised and increasingly raised here in the German context it was about the compatibility with wholesale markets, and to my mind, that's one of the more difficult challenges or one of the more difficult arguments to address. So what about integration? How do you integrate large numbers of solar and wind turbines and bioenergy projects, geothermal projects into competitive wholesale markets? If you're below as I mentioned roughly 25 percent, the integration challenges are fairly manageable, but what happens once you get to 50 percent? What happens if we get to 75 percent or even above that and somewhere in the 100 percent range of electricity supply in the mix coming from renewable technologies? Can we continue to finance everything via long-term fixed price contracts? Will that not result in increasing issues around flexibility? Increasing issues around good integration? Increasing issues around negative pricing? What does that mean long-term? And I think that more than anything else, those are the kinds of questions that have prompted a pause and the beginnings of a shift in strategy among decision makers here in Europe. Now some of those integration challenges can be solved in a range of different ways, and I lay out a few here and there's certainly more that could be added, but the challenge is to correspond supply and demand in the environment in the marketplace.

Now traditionally demand has been relatively inflexible and we've had to turn on and off power plants in order to meet that demand as it fluctuates over the course of the day because of day and night but also because of temperature and other factors. Now in the future, we're already moving now to a market where demand is becoming increasingly flexible where we're seeing new programs like in the PJM market in the United States as well as here in Europe starting to explore demand response. There's a new initiative in Ontario to launch demand response in the marketplace and to try to get market prices for that. We're seeing a shift towards making demand more responsive. In other words, to make demand dispatchable so you can effectively flick on and off loads and that would mean that if you have an abundance of solar in the market for example as in a sunny day like today in Germany, you could flick on a large number of loads to help

sponge up, to help use that available supply in the marketplace that could ease some of the integration challenges and could also help avoid challenges like curtailment.

There's also a need for an increasing integration between electricity, the transport sectors as well as the heating and cooling sector. There's a movement now to start re-electrifying or to start increasing the electrification of the heating and cooling sector. Cooling traditionally has been electrified but heating in particular can provide a valuable way of allocating a valuable load that can be turned on and off, scaled up and down in response to the supply in the network. So again, when there is an abundance of wind in the network, a number of thermal loads using heating could be stored. You could store it in hot water or in other forms within individual buildings and that's something that could be remotely monitored and remotely dispatched to help ease some of the integration challenges of getting to high shares of renewable energy in the mix.

Another thing that's likely going to help in this challenge in addressing some of these integration challenges is improved forecasting. There's significant innovations taking place around the world, not only in Europe and the U.S., on improving the forecasting of both a variable or weather linked renewables like solar and wind. I think that's going to play an important role as well. The fourth point that's likely to contribute to this significantly in the years ahead is storage. Now storage doesn't necessarily need to be battery storage. There are other forms of storage that can play a similar function but ultimately storage can provide another dispatchable source of demand that can help use abundant supply in the network when it's available. The fifth is that electricity markets can start to encourage more self-consumption. In other words, encouraging homeowners and businesses to use more of their domestically produced on-site renewable energy at home or in their business before they're exported to the grid because less power gets exported to the grid it makes it easier for distribution system operators as well as transmission system operators to integrate that power into the network.

And finally, another component is increasing the size of the balancing areas, balancing areas between the different system operators, and ultimately the larger the balancing areas, the easier it is to wheel power across larger geographic regions which allows a significant smoothing effect across different electricity markets and can allow greater shares of both wind and solar and other renewables to be effectively integrated. Now obviously that comes with market agreements between the different regions and also requires in many cases expansions to existing transmission infrastructure but the integration challenges can be solved in some of those ways. So the challenge becomes if we think of renewable energy policy as a way to encourage more supply in the marketplace, we're going to then need to deal with the demand challenges and how to better integrate all of that supply because we're going to have in many times of the day and many times of the year more supply on the network

than our current systems can cost effectively integrate and that results in curtailment and curtailment is negative both for the system as well as for engineering standpoint but also for investors if they aren't compensated for that curtailed power, so we're going to need to move to a future if we maintain policies that support new supply like feed-in tariffs, like auctions and tenders. We're going to fundamentally need to deal with these integration challenges and make electricity markets more responsive, more dynamic in the way that they function but also to make demand more responsive to the realities of supply and that represents an inversion of where we've been historically where supply has traditionally been adapted to demand, so we're going to need to flip that around to make demand more responsive to the availability of supply.

Now getting to a couple of the last slides in the conclusion. As I've highlighted, the electricity system of the future is going to need a massive volume of decentralized finance. This is going to require power plants of various sizes and shapes, various technologies, financed on the supply side. It's going to require new smart distribution and transmission infrastructure, more intelligent interactivity between the different components, both between loads as well as between supply sources. It's also going to require an expansion in the trend towards electrification of the transport sector. We're seeing significant moves in certain markets like Norway as well as in certain parts of the U.S. towards the electrification of the transport sector. No one knows what role that's going to play or how that is going to play out in the electricity markets of the future, but we are going to see more of that in the years ahead. I don't think anyone doubts that. That's going to create new challenges but it's also going to create new opportunities. There's the potential to start dispatching the charging infrastructure in relation to the availability of supply in the network, and there may be already a price incentive to start to use that when wholesale prices are low, so when there's an abundance of PV in the network as we saw from the charts earlier, there may be an opportunity there to start to use up that low wholesale cost power and deploy it into transportation infrastructure, so there could be some interesting synergies there that emerge in the years ahead and the same thing plays out on the storage side whether pump storage, pumped hydro or compressed air systems.

Now this – all of these different things in the renewable energy market we often focus on the technology side. We often think about the different technologies, and we don't often think about what's necessary to finance all of these different technologies. And different arrangements are going to prevail for different technologies in this environment. This is going to be a massively decentralized affair and different jurisdictions are going to approach this in a multiplicity of different ways, but one of the key arguments that I'd like to make here as we wrap up is that the transition to a sustainable low carbon system is going to be faster and easier for everybody if finance is available at scale and at reasonable rates. In other words, if there's large volumes of finance that meets with regulatory

conditions that make it attractive to provide low cost investment into that marketplace and I think the onus is, therefore, on policy makers and on regulators and on governments around the world to really focus on creating and maintaining those policy and regulatory conditions that allow large scale finance to take place of the kind that's needed to get us to a low carbon power system in the future. Now in many cases that's not going to as we're seeing currently in markets like brazil, as we're seeing currently in some markets like Taiwan, the use of auctions can be used in a complementary way with feed-in tariffs. They can be used with different mechanisms.

We see in the United States a very widespread use of net metering policies. There's going to be a need for a diversity of policies as well, and we likely will continue to see that, so theirs is no silver bullet. There is no single approach that's going to solve all of the challenges but one of my – one of the points that I'd like to emphasize as we wrap this up is that stable financing conditions are a critical part of increasing the flow of capital into the market and reducing the cost of that investment to support the transition ahead and for that so far the best mechanism to achieve that and to allow broader base participation in the electricity market has been the feed-in tariffs, and that's why governments around the world continue to look at it as an attractive policy option to meet the kinds of challenges that they're facing. So as Germany begins to shift away, other markets in the world may find that they're still at 1 or 2 or at 4, 5 or at 7 or 8 percent of the electricity mix and may still find it attractive to continue to use feed-in tariffs for decades to come as they scale up their markets and as they begin to – as they try to focus on attracting investment to the marketplace.

For many places around the world, that is the primary challenge. For markets that are – a lot of the regulators I work with in Africa and in parts of Asia, a key challenge is attracting investment, and if you want to attract investment, feed-in tariffs still remain a very compelling policy tool with a very strong track record, obviously some very good lessons learned from some of the markets that we've seen such as Spain but comparatively a track record that supports continued interest in the policy mechanism. Now we're seeing some changes. We're seeing some of the evolution in the electricity market requiring new ways of thinking about these challenges, and as I've highlighted at the beginning, there is no one size fits all, there is no blueprint here for the way this is going to evolve, but I think that the future of renewable energy policy should be thought of more carefully through the lens of finance rather than through the lens of economics in order to understand what the marketplace needs in order to finance the kinds of investments that we need. If we focus on wholesale spot markets alone which is the traditional economic approach, we're likely going to halt the energy transition, what the Germans call the [inaudible] all together because as we've seen even conventional assets are not financeable in that environment, so I think the discussion we need to

be having around the world today is what can we do to maintain stable low risk conditions to support renewable energy investment worldwide, and I think there's a lot of lessons that can be learned from the experience of major countries and different countries are ultimately going to choose different strategies to solve those challenges but long-term fixed price contracts remain a key part of the policy tool kit.

So with that, I'll wrap up. There's a few citations, a few reports that some of the viewers, some of the listeners may be interested in downloading, and I believe we'll shift to questions which Sean is likely going to coordinate and then start to work through, so thank you very much.

Sean Esterly And thank you Toby for the excellent presentation and actually do you want to leave up those reports that you just had on that second to last slide? We could leave those up during the question and answer session if that might be useful?

Toby Couture Sure.

Sean Esterly All right. Heather, if you could send the capabilities back over and then we can get that slide up.

Heather Well, actually I've just posted it now from my side. [Inaudible].

Sean Esterly Okay, great.

Heather Okay, great.

Sean Esterly And we can get it up there so yeah, we'll just leave that up in case anyone wants to access those right now or write down where they can access those. And just a reminder to the audience, if you do have any questions for Toby, you can submit those through the question pane in the GoToWebinar window, and Toby, we did receive a number of questions. So I'll just get started with the first one that we received, and it asks, did FITs drive down solar PV costs alone or how much would you estimate is attributable to China dumping of solar PV below cost in the U.S. and elsewhere?

Toby Couture I think that the move to China definitely helped reduce the base manufacturing cost of the panels, but as – I think that's arguably been overstated in many of the analyses that have been done partly because the PV sector, PV manufacturing as manufacturers know is largely components, is largely machines and robots, so it's a highly mechanized process which means that shifting it to a lower labor cost environment certainly has had an impact, certainly has played a meaningful role but whether it's been the driver, I think is a debatable point. I think that the more important thing is that feed-in tariffs have helped drive markets scale. It helped market scale up and created a gigawatt scale market per year for PV components that has helped create a larger number of

manufacturers, more competition in the marketplace and more privately financed R&D, more individual companies financing their own R&D to improve their components whether in China or in Germany or in the U.S. and that's been a powerful driver of cost reduction. So in contrast to traditional views of government funded R&D, I think certainly in the early days PV was largely government – PV R&D was largely government financed, but in the last decade, the majority has shifted towards privately financed R&D by the business sector as markets have grown.

We've gone from you know a few megawatts per year of PV installed to 10s of gigawatts installed in a matter of years, so I would tend to argue that feed-in tariffs have been a very powerful driver because they've helped bring markets to scale. They've helped create larger opportunities and through economies of scale, we've seen costs come down. Now I don't – it would be hard to comment specifically on whether the dumping has played a role. I think low cost panels make solar more attractive for everyone and that has certainly played a role, but I think the more important driver here is the scaling up in the marketplace, the dramatic scale up that we've seen over the last 5 years in particular.

Sean Esterly Thanks Toby. And the next question comes from David Cline who also says hello, and his question for you is wouldn't another key argument for FITs be that they lend themselves to securitizing as part of the strategy of gaining access to broader public markets as sources of renewable energy finance?

Toby Couture That is an excellent question, David. I just shared a – I moderated a panel in Munich at the big intersolar conference last week specifically on this topic, so it's very, very much on my mind of late. For those of you listening who don't fully understand the securitization, securitization effectively is a way of taking a large number of different renewable energy projects and bundling them together into larger packages that can then be sold as a bond like investment to investors around the world, to the public markets as they're sometimes called and that ability to aggregate them together, aggregate tens of thousands of different solar projects and potentially dozens of different wind projects into portfolios into baskets then enables you to issue those as securities to investors around the world, and that can be a powerful way to increase the flow of investment to the sector.

And I think securitization is definitely a topic that I think it's one of the most exciting topics in the renewable energy finance space at the moment, and I think feed-in tariffs do lend themselves or do support securitization in some ways better than other mechanisms partly because the pricing terms are standard, so you can bundle a number of vintage contracts that are assigned in say 2012 or 2013. You could aggregate all of those contracts of that vintage and cluster them together into a package, so that has significant advantages over a disaggregated basket with many different prices for different projects in different jurisdictions. So the

standardization is a very important component of enabling securitization and for that we need more stable regulatory conditions and long-term contracts are obviously a very – also very significant advantage because they allow those bundles to be packaged together and to issue – to be turned into issuance that can be – that can produce revenue streams over 15, 20, even 25 years, so I think that's a great question and that certainly could be another very important advantage of FITs versus other mechanisms in the years ahead. To close off, one of the ways – one of the reasons that securitization discussion is so important is that it's yet another way of reducing the cost of finance to the marketplace. So securitization could reduce the cost of debt in particular and could help increase the quiddity around the world including in Africa and other emerging markets, so this is definitely an important and active debate.

Sean Esterly Great. Thanks, Toby. The next question that we have asks, the use of FITs that results in increases in renewable energy feed-in, would that – could that possibly then lead to reduced volumes in the spot market?

Toby Couture I'm not sure I understand the question. Can you run that by me again?

Sean Esterly Yeah, it is worded a little strangely so I'm trying to interpret it here. But can the use of FITs which then results in increased renewable energy feed-in result in reduced volumes in spot markets?

Toby Couture That depends on whether the FITs are being purchased outside of the spot market or whether they're being transacted on the spot market. So that's an interesting question. I think, and you're right, in some cases the utility is the direct off-taker so that power never makes it onto an exchange or a spot market so to speak. In Germany, it's currently aggregated so there's one name – one buyer who essentially buys most of the renewable power and is tasked with marketing that power into the spot market, so that way it directly impacts spot markets through that means. Now different markets may structure this differently, so you're right, there may be ways of mitigating that – mitigating the negative price suppressing effects of renewable energy by diversifying the location to which that electricity is marketed in the marketplace, and I think we're already to see that here in Europe with the rise of what are sometimes called aggregators or these new utility business models that can buy electricity on a bilateral basis and find a buyer for it as sort of a middle man and that can keep that power off the spot market which can reduce some of the volume impacts and can also reduce some of the price suppression effects that we're seeing. So that's a very interesting question and I think that's an active – that's an area that the policy makers should certainly look at more closely is who the off-taker is and does it get fed into the spot market and in what way?

Sean Esterly Great and we do have a somewhat related question for that. And the question states, I'm not at all convinced that FITs have much to do with negative spot prices in wholesale markets. Having renewable energy with

essentially zero marginal cost together with binding transmission constraints seems to me to be enough. Can you comment on that?

Toby Couture Yeah, I think the only primary reason why FITs drive that is that they are responsible for the surge in volume, the surge in supply coming onto the market. So when the sun shines, you get gigawatts of capacity entering the market. It's almost instantaneously with the beginning of the day on a sunny day and that is responsible for driving some of the price dynamics. With wind that renewable energy interacts with the spot market. So whether FITs are causing that, FITs were responsible for attracting that supply to the market in the first place and then that supply is then interacting dynamically with the market after the fact, so I think you know we could get into a cause and effect debate but I think that fundamentally FITs were what brought all those wind farms and solar projects to the market and, therefore, in some way causally responsible for those price effects, and I see – I think it's difficult to argue otherwise but maybe I misunderstood the question. I hope I understood it correctly.

Sean Esterly Yeah, I think so. Thank you, Toby. And the next question asks, if it would be possible for you to just spend – just to discuss on how FITs might be or have been designed for solar process heating.

Toby Couture The UK, yeah, the UK is probably the best example for this and I would encourage you to look at the DECC website, the Department of Energy and Climate Change, and they have the renewable heating incentive which is essentially a feed-in tariff for the heating sector, and there are some different provisions that apply. Obviously you need metering infrastructure to meter heat but fundamentally the same principle applies. A fixed purchase price is paid for the supply of heat into the built environment, and again, what that does is quite simple. It provides standard contract terms and a clear price for the value of heat, and if it's attractive to supply heat at that price, then investors will invest in it and that's been a significant driver of the heating – recent heating investments in the UK market. So I think the UK is a bit of a – I would argue a leader on this. I don't know that there are any other jurisdictions in the world that have a policy on heating that's quite as sophisticated as the UK or quite as carefully designed, so I would encourage you to look more closely at them certainly in following that line of thought.

Sean Esterly Great. Thank you, Toby. Next question asks in the context of India, FITs have been much more successful as compared to tradable renewable energy certificates, and this is because of a counterparty risk involved in the RECC approach as distribution companies don't buy RECCs even if they are bound to do so. So for an economy like India, what in your opinion would be the best alternative to FITs?

Toby Couture Well, India is already experimenting with almost everything under the sun in terms of policy. There are as you mentioned certificate markets. There are small scale feed-in tariffs in certain states like Gujarat. There are

tenders that are issued for wind farms. There are also policies similar to what the U.S. has in terms of tax incentives and accelerated depreciation and India has almost every conceivable policy coexisting at the same time in a very complex provincially segmented marketplace. So there's a lot of different things happening and I think regulators in India have been quite keen to work more on the way that – on improving the sort of harmonization across the different regions in India. I think that to attract finance to the market having long-term contracts remains a standard – remains an attractive policy approach, whether that's done through feed-in tariffs or through tenders I think is a different question, but India is also one of the largest – it's the largest democracy in the world and also the largest – one of the largest electricity markets in the world, at least potentially largest electricity markets in the world once rates of electrification rise.

So there's also significant opportunity to encourage more actors into the marketplace. Rural – people in rural communities, individual homeowners, businesses, investors from all different parts of society, I think that having an open access approach similar to a feed-in tariff would remain a powerful way to attract investments of the sector partly because of the fundamentally decentralized nature also of India's grid, so I think that whether you know it remains to be seen whether the new Modi government will draw on some of the lessons learned from the experiment in Gujarat with the FITs and try to scale that up nationally. I think that that remains an open question, but yeah, I think there's a lot of great people at the India – the electricity regulatory commission in India, and I think that they're certainly looking at this very closely so I think it's a very good question.

Sean Esterly Great and moving on to the next question from our attendee. They want to thank you for the very informative presentation and they also state that you mentioned encouraging self-consumption as an important aspect for integration of higher shares of renewables. How do you see the developments in Germany that aim at including self-consumers in paying certain electricity levels? Isn't this a regulatory risk in the perspective of finance?

Toby Couture Yes, self-consumption markets are one of the hot topics that are emerging – I'm actually just finishing up with a team of other researchers a report for the IEAs renewable energy technology deployment team on what are called prosumers on exactly this topic of self-consumption in the residential sector. So this is also very much at the cutting edge and I think there are no roadmaps, there are no clear blueprints for how we move forward here, but let me try to articulate some of the challenges and some of the tensions. The self-consumption is driven at least in Europe where it's taking place primarily by high electricity prices, high retail electricity prices. So in Germany for example, current retail prices are on average about 29 euro cents. That translates into just over 40 U.S. cents or approximately 40 U.S. cents per kilowatt-hour now with taxes. In markets

like Spain, it's still significantly lower than that. You're somewhere in the 16, 17 euro cents range, but even at 16 or 17 euro cents in Spain with a much more attractive solar resource, it's attractive to set up solar on your own roof. So we're seeing a rise as feed-in tariffs in Spain have been scaled back or have been – there's a moratorium effectively underway. The market has started to find new ways of selling PV and one of those is by encouraging or by tapping into that self-consumption market. So for small businesses, for individual homeowners, it can already be very cost effective in many markets across Europe to supply a portion of your supply with your onsite PV system. Now that can be for households that'll be 2 to 3 kilowatts perhaps, maybe 4 kilowatts on the higher end for larger households. That depends on your household profile, but that could be a new – this could be a new evolution in the future of electricity markets around the world as PV components come down so far in cost that it becomes attractive for individual homeowners almost anywhere to supply their own power on-site, and I think that will have major implications for utility business models. It's going to have major implications for policy clearly. So if self-consumption becomes the dominant way through which small scale PV in particular is financed, then maybe it won't be necessary to have mechanisms like feed-in tariffs for projects under 10 kilowatts because it'll just – it'll be attractive already for households to do that on their own.

Now I think for larger projects in the megawatt scale it's still necessary to have an off-take agreement of some kind; if not necessary, it certainly helps and so self-consumption is likely to in the years ahead is going to erode a significant share of the residential load slice over the many utilities current sales forecasts and that's going to have very potentially disruptive implications, and I think we're just at the beginning of that conversation. So the policy implications aren't clear. We tried to sketch some of those out in the report which actually will be available later this week. I think it's supposed to be published some time before Friday, but there are no clear policy solutions and there are no clear roadmaps as I mentioned, so this is very much an evolving space and one that probably will continue to interact with or have impacts on renewable energy policy at the national and local level in the U.S. as well as around the world.

Sean Esterly Great and we probably have time for another two or three questions, so I'm moving onto the next one. All right Toby, what preconditions especially in terms of the maturity of electricity markets have to be fulfilled for a transition from a feed-in tariff to a feed-in premium scheme?

Toby Couture That's a great question. Obviously the premium needs to ride on top of something. Needs to be some sort of benchmark on top of which a premium is being offered. So that benchmark could either be and typically is wholesale prices at one level or another. Now wholesale markets are still only a small share of total transacted electricity in most markets of the world. Even in the most advanced markets it's still less than half of supply that's transacted through the wholesale market. But fundamentally a price

is needed that on top of which a premium can be offered and ideally that price would be transparent. In other words, one could look it up at any time of the day and one can also project it backwards and project it forward to look at where the price trends have been so there should be an historical track record of that price as well as day ahead, week ahead prices and so forth to help again reduce the risk for investors. So ideally it's some kind of spot market. I don't think it needs to be necessarily. I think there may be other ways of designing that but obviously getting to a spot market already requires a fairly sophisticated level of electricity market design. So for developing countries if there were to be interest, I think one case that we're starting to see now in islands around the world are in markets with very high generation costs because of diesel. It's not a premium that's necessary but rather a discount to the avoided cost because the avoided cost of the utility in jurisdictions like Hawaii or in the South Pacific or in the Atlantic is you know will range anywhere from 30 U.S. cents per kilowatt hour to over a dollar per kilowatt hour.

So with supply costs that are that high, there may be ways of striking a sort of negative premium you know or you basically offer a discount to the avoided price, the avoided cost generation price and that would have to be negotiated through regulatory hearings, so if you could get a regulatory hearing with an incumbent utility it could work both ways. You could essentially have a regulatorily determined avoided cost price on top of which or below which a premium would ride or a price discount or a price premium would ride, and I think that may be one way of doing that in the absence of an electricity spot market per say. But I think that's a very interesting question. I hope that answers broadly the sort of focus of it.

Sean Esterly Great. Toby, we have time for 1 more quick question or hopefully a quick question, and it is in the jurisdictions where we have gone beyond retail grid parity for grid connected solar PV, are there still arguments that can be made for advanced retention – I'm sorry. Are there still argument that can be advanced for retention of FIT laws? For example, the rules around connection to the network found in the EEG?

Toby Couture For small systems if – can you read the first part again?

Sean Esterly Yes. In the jurisdictions where we have gone beyond retail grid parity for grid connected solar PV.

Toby Couture Okay. Yeah, and I sort of eluded to that in one of my previous comments that you know maybe if PV module costs continue to come down, you know we had – the head of the Fraunhofer Institute here in Germany in Freiberg. [Inaudible] recently said that PV – they're expecting the LCOE of PV to be somewhere in the 5 cent range, 5 euro cent range per kilowatt-hour by 2018 or late 2017 if current trends continue. So if you get to that sort of pricing point at around 5 euro cents per kilowatt hour for small systems that you can just mount on your roof without significant you know mounting architecture or just hang out of your window as many

people are doing here in Germany, the case for you know a long-term purchase contract is comparatively weak. I think a lot of this could start to just happen spontaneously. This is what's called gorilla PV for those of you who haven't been following this. Here in Germany where people can just develop small systems on their own, hang panels out of their window effectively and produce their own power by plugging it directly into the building's network and wipe out daytime loads.

So if we get to a price point, a price environment which again as you pointed out, we already are in many markets. We're well below grid parity in most of the markets. We're well below socket parity in most of the markets here in Europe with a couple of exceptions, so and certainly in many markets in the U.S. as well. So this is a very, very cutting edge topic and I think there are no as I mentioned the case for FITs for long-term fixed price contracts in that kind of environment is certainly significantly weakened and may not need them at all. So then we move maybe to an environment where certain factors of like maybe tax incentives for individual households to produce their own power become attractive. The debate, however, then shifts towards grid costs. Who pays for fixed grid costs? Because in many markets grid costs represent anywhere between 30 and 50 percent of total electricity system costs, and if there's decreasing volume sales through the network, through the utilities, or through the spot market, then that means that those fixed costs are recovered from a smaller customer base and that ultimately is going to mean that the risk getting into sort of a stranded asset debate where there's just not enough revenues to support the financing of that infrastructure and this is what many commentators in the U.S. in particular have called the death spiral you know where utilities could start to face eroding revenues and not have enough money to actually pay for fixed system costs. Now that is potentially a challenge we're going to have to deal with in the next decade, certainly in the next 20 years as markets really scale up and as PV becomes more attractive at a residential scale because we are beyond parity and we are beyond socket parity in a growing number of parts of the world.

So in that sort of brave new world, I think we are going to need new policies and new ways to either incentivize and/or control distributed PV uptake because otherwise it's going to be difficult to manage and it's going to be difficult to finance fixed infrastructure and we risk getting into issues like stranded assets and also potential bankruptcies in the utility sector which presents a new set of challenges of its own, so I think those are some of the directions that we're seeing and I think you know because we're beyond those thresholds of grid parity and socket parity that this can unfold in a dozen different ways and it probably will unfold in many different – as many different ways as there are markets around the world so certainly a great question and a space to continue watching.

Sean Esterly Great. Thanks again, Toby. And we are out of time so I'd like to just move onto quickly to the attendee survey and before we do that actually I would

– there was a couple of questions we did not have time to get to, so Toby if it's okay with you, I will email you those questions along with the attendee email address that asked those and then on your own time you could perhaps respond.

Toby Couture Sure. Yep, that sounds good. I'd be glad to.

Sean Esterly Okay, great. Great. If we did not get to your question from the audience today, I apologize but I will forward those along to Toby so that he can respond when he has a chance to. And so Heather if you could go ahead and display the first poll question. And the question is, the webinar content provided me with useful information and insight, and you can respond to the poll directly in the GoToWebinar window. Great and the next question please. The webinar's presenter was effective? Great and the final question please Heather. Overall the webinar met my expectations? Great.

Thank you very much for answering our survey and on behalf of the Clean Energy Solutions Center, I would just like to thank Mr. Toby Couture again for the great presentation and discussion session today and to our attendees for participating in the webinar. I very much appreciate everyone's time, and I do invite our attendees to check the Solutions Center website if you'd like to view the slides and listen to a recording of today's presentation as well as any previously held webinars. Additionally, you'll find information on upcoming webinars and other training events, and we are also now posting webinar recordings to the Clean Energy Solutions Center YouTube channel, so please allow for about 1 week for the audio recording to be posted and then we also invite you to inform your colleagues and those in your networks about the Solutions Center resources and services including the no-cost policy support. And with that I hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.