CLEAN ENERGY SOLUTIONS CENTER
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Renewable Energy Transition: The Future of Renewable Energy Policy

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Webinar Presenter

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Stephanie Bechler Hello, everyone. I'm Stephanie Bechler 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. Today's webinar is focused on the renewable energy transition, the future of renewable energy policy.

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.

Before we begin, I'd like to go over some of the webinar's features. For audio, you have two options. You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the Mic and Speakers option in the Audio pane. Doing so, we eliminate the possibility of feedback or echo. If you choose do dial in by phone, please select the Telephone option and the box on the right side will display the telephone number and audio pin you should use to dial in. Just a reminder to everyone else on the line, we ask you to mute your audio devices while you're not presenting.

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An audio recording and the presentations will be posted to the Solutions Center's training page within a week and will be added to the Solutions Center's YouTube channel, where you can find other informative webinars as well as video interviews with thought leaders on clean energy policy topics.

Today's webinar is centered around our presentation from our guest panelist, Toby Couture. He has been kind enough to join us to go over the key findings of a recently published report, "RE Transition, the Policy Frameworks for Cost Competitive Renewables." Before Toby begins his presentation, I'm going to provide a short overview of the Clean Energy Solutions Center initiative, and then following the presentation, we will have a question and answer session where Toby will address questions submitted by the audience. Then there will be closing remarks and a brief survey.

This slide provides a bit of background in terms of how the Solutions Center came to be. The Solutions Center is 1 of 13 initiatives of the Clean Energy _____ 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 include 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.

The Solutions Center has four primary goals. One, it serves as a clearinghouse of clean energy policy resources. It also serves to share best policy practices, data, and analysis tools specific to clean energy policies and programs. The Solutions Center delivers dynamic services that enabled expert assistance learning and peer-to-peer sharing of experiences. And finally, the Center fosters dialogue on emerging policy issues and innovation along the globe.

Our primary audience is energy policy makers and analysts from governments and technical organizations in all countries, but we also strive to engage with the private sector, NGOs, and civil society.

A marquis feature of the Solutions Center provides a no cost expert policy assistance known as, "Ask an Expert." The Ask an Expert program has established a broad team of over 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost. For example, in the area of sustainable energy policy, design, and laws we are very pleased to have Chad Laurent. He is a senior consultant and general counsel for the Meister Consultants Group, serving as one of our experts.

If you ever have any policy assistance in sustainable energy policy design or any other clean energy sector, we encourage you to use this valuable service. Again, the assistance is provided free of charge. If you have any questions for

our expert, please submit through our simple online form, cleanenergysolutioncenter.org/expert. Or, to find out how the Ask an Expert service can benefit your work, please contact Sean Esterly directly at shawn.esterly@nrel.gov. We also invite you to spread the word about this service to those in your networks and organizations.

Now I'd like to provide a brief introduction for today's panelist, Toby Couture. He's the founder and director of E3 Analytics, an international renewable energy consultant based in Berlin, Germany. He works on a wide range of topics in renewable energy, including policy and regulatory analysis, market research strategy consulting, and finance. He's worked extensively with policy makers and regulators on renewable energy strategy and has advised over 40 national governments around the world. With that, Toby, I'd like to welcome you to the webinar.

Toby Couture Thanks, Stephanie. Let me just get the presentation up. Does this work through my screen or do you have a platform that will –?

Stephanie Bechler Your screen looks great. If you could just put it up to full screen mode, that would probably be…

Toby Couture Sure. I think, in the past, I didn't have to so I didn't have this ready. So, first, thanks a lot Shawn. Thanks, Stephanie, for kicking us off. And thanks, everyone, for joining. I'm going to try to keep my overall comments fairly streamlined so that we can open up a little bit more time for conversation and discussion afterwards. I think there's a lot of important aspects to the report that we recently published, and I think there's a lot of key issues that still haven't really had good answers—good, important questions that we just haven't, in terms of the renewable energy—analysts, and consultants, and researchers around the world that just haven't—we don't really quite have good answers to yet. So I see this as an opportunity to start having that conversation and start broadening the discussion around some of these key issues.

[Crosstalk]

Toby Couture Let's get started. First, a few quick words about the authors. I'm not the only author on this report. A close colleague here in Berlin, Doctor David Jacobs, has been leading the project in terms of project management. We were also joined by three analysts from NREL—Owen Zinaman, Jacquelin Cochran, and Carlin Corey, who has now recently moved on to Black and Lich, I believe in Colorado, so she's still in the area. We had a pretty strong team from day one, and we have managed to get this out on time, which was also a pleasant surprise. Sometimes these projects go well beyond the anticipated completion date. We had originally planned to finish in March, and here we are.

We've already done the quick profile, so let me dive right in. Here's a brief overview of the presentation and a short summary to kick it off.

Renewable energy policy has historically been focused on bridging the cost gap between renewables and conventional technologies. That's been part of the underlying rationale for using renewable energy policy at all. There's been fossil fuels or nuclear options were considered, or were in the market lower cost, and policy was used to help bridge that gap so that renewables could be integrated into the market or could compete in the market with those technologies. But now, what we're seeing around the world, and as many of you, I'm sure have noticed in recent months and in the last couple of years, renewable technologies like solar and wind are increasingly outcompeting fossil and nuclear in competitive tenders around the world. So we've seen several recent examples from the Middle East, from Latin America, as well as from the U.S. and Europe where the price point of onshore wind and solar PV in particular is undercutting that from fossil and nuclear projects.

This has led to a bit of a debate around whether there is still a need for renewable energy policy. In other words, is it time, perhaps, for renewable policy to call it a day and declare mission accomplished? One of the conclusions from the report is, not quite. There's a range of factors including that a lot of renewables compete against currently quite low wholesale market prices. There is, in many markets, excess generation capacity. In many cases, renewable projects have to compete against other power plants that are already amortized—in other words, where their actual costs have already been paid off. And there's the incomplete, or in many cases, non-existent pricing of environmental externalities, so whether carbon or other. There's also a certain inertia associated with existing utilities in many markets, and inertia associated with the existing asset base—so the existing power plants, the existing generation fleet—that is in itself hard to overcome, and takes time.

So if you add all of that and you combine it to inherent capital intensity of renewable energy projects, it makes it difficult to imagine a future—at least anywhere in the near future—where renewable policies could be phased out completely. There's still, in many cases, a pretty clear not only public policy rationale, but also a regulatory rationale for some policy framework governing investment in this sector.

A further point that I think is important not to forget is even though solar and wind have moved down the cost curve quite rapidly in recent years and are now broadly cost competitive, there are many other renewable technologies that are still higher on the cost curve, of which I have listed a few here at the bottom—offshore wind, concentrating solar power, wave, title, and so on. We'll get into that a little bit more and what that means in a few moments.

I want to kick off the presentation, also, by saying that making predictions is tough, especially about the future. I think there's an inherent difficulty in talking coherently about where we're going to be in 5 years, let alone 10 or 20 years in terms of renewable policy. We approached this with some degree of humility.

So, the evolution. One of the key points underlining the entire report is that policy evolution is fundamentally driven by cost evolution. So as renewable

energies come down in cost, the policies that governments have been using around the world have also changed, and have changed in lock step. And we see certain kinds of patterns and certain commonalities throughout this evolution. This graph captures some of what we mean by that and some of how we've characterized this in the report. Building on this overarching framework provides a way to understand the evolution of renewable policy from the 1970s until today.

So we break this down into three key phases. The first phase is the early commercialization phase. In this phase, we really see governments focusing primarily on research and development, R and D support, cash grants for particular projects, and a series of pilot projects. The primary goal in this phase is just to demonstrate the technical viability of a particular technology and improve the overall performance over time. We saw this with wind power through the 1970s into the 1990s as wind power became a more and more mature technology. Many early projects failed or only lasted a few years while engineers and R and D experts really focused on ironing out the bugs and trying to get the performance up and the longevity up. Some of the labs around the world, including NREL, have played a really key role in driving this early commercialization phase.

After that phase, we enter what we've called here the policy support phase. During the policy support phase, you see sort of standard toolkit of renewable energy policies emerge—so feeding tariffs, feeding premiums, renewable certificate markets, various tax incentives, as well as auctions and net metering. This standard tool kit is really used fundamentally to try to bridge the cost gap between the conventional alternatives and provide a better foothold in the market for these increasingly mature renewable technologies. So we see these various policies being used, particularly for wind, for solar, for biogas and biomass projects, as well as for micro hydro, and in many cases, geothermal. So you see, the Policy Support Phase, there's still a clear gap to cover. Renewables are still more expensive, but the market is starting to scale up.

The third phase—and this is really where we focus in the report—is what we've called here the policy framework phase. This signals a move away from explicit government support or explicit government subsidies towards more of an overall enabling environment that supports investment. So the policy framework phase is no longer really about providing explicit support. It's more about maintaining bankability and enhancing overall system flexibility to increase or improve the integration of renewables into the system.

We felt that we really needed a new phase to capture what's going on because in many markets, as I pointed out in the beginning, technologies like wind and solar are broadly cost competitive. It's not a question of providing additional popups or additional support. What we're really talking about is, how do you maintain bankability for these technologies in different market circumstances? And that's really one of the key takeaways from the report and one of the things that we focus on as we'll see in the slides ahead.

A bit of a visualization of how this breaks down. There are three core benchmarks that renewables compete against. This is something that is often lost in the debate around words like grid parody or socket parody. A lot of these nuances are lost in that debate. So the first basic benchmark that renewables were competitive with is the retail price benchmark. You can see that in the graph here, sort of representing that basic midrange where retail prices fall. So in some countries like Germany, where I'm based now, retail prices are somewhere around 30 cents a kilowatt hour, whereas many states in the U.S. they are anywhere between 10 and 15, or 10 and 18 cents. In markets like South Africa, you're somewhere around the 8 to 10 cent range. You see different jurisdictions having a different retail price benchmark, and that is one of the benchmarks that renewables compete against but it's not the only one, even though it's the one that we often focus on when we talk about grid parody or socket parody.

The second core benchmark is the LCOE of conventional alternatives. So that would be if you had an open tender or an open auction, what is the LCOE of different technologies against each other? So natural gas versus wind versus hydro versus biomass versus PV. What is the LCOE of various technologies against one another, and are renewables competitive with that? So that's the second benchmark you can see there on the graph.

And the third and final one, and in most markets, the most difficult one to achieve or be full cost competitive with, is the wholesale market price benchmark. Or, in markets that don't have wholesale markets, what we would consider at the utility of what it costs. In many cases, that is basically just the running or operating costs of amortized power plants. So that would be the running or operating cost. The hydro dam of a nuclear plant, of a coal plant, and so on.

It's important to really understand these three key benchmarks and why they matter in this story, and we'll get to this a little bit more in the slides ahead.

As I pointed out, the fundamental focus of the report is on what happens when renewable technologies surpass LCOE cost competitiveness. So what happens when renewables are actually cheaper on the levelized basis than other technologies like natural gas, or coal, ____. That's really where we try to focus in the report.

Another thing that's worth pointing out and that some of you may have noticed—I'll just go back up—is the concept of the policy bedrock. You'll see this at the bottom, underlying all three phases. We felt there was a gap in the literature and a gap in the thinking on renewable policy that needed to be filled or at least needed to be addressed and sort of made concrete. So we coined this term, the policy bedrock. That refers to the underlying regulatory and permitting related elements that make investment in power generation possible. So that includes a whole range of things like open access rules for the good connection, clear permitting, environmental permitting, siting, etc. Environmental performance standards—so what are the actual regulatory standards that a power plant has to meet? The technical standards relating to ISO compliance and various things. A land access regime, so a way to

actually get projects built, get access to the land, etc., as well as R and D and innovation related funding.

So all of these things are, in some sense, present at all stages. As you can see here in the depiction, these aspects are critical throughout the policy evolution, throughout the cost evolution. It's not like we can suddenly reach the current phase of advanced cost competitiveness and just stop doing R and D, or stop innovation related funding, or abandon all technical standards. These things remain common and consistent, though they change throughout the various phases. So that's what we've called here, the policy bedrock.

Now, let's turn to what we've identified as the three key pillars that future power systems will need to have in order to transition to a more sustainable power system. The first key pillar is projects will need to be bankable. That sounds fairly self-explanatory or fairly obvious, but it's surprising, particularly looking at the developments in Europe recently, how little attention from a policy perspective has been given to the actual question of fundamental bankability. Are projects investable in my jurisdiction? We underscore this in the report as something of a litmus test for renewable policy in the future. As markets get more complex—as the policy frameworks get more complex, bankability can be used as a bit of a litmus test to check whether the overall framework is still sufficient to enable scale up—to enable project investment to happen.

The second main pillar is flexibility. As the share of renewables grows in various jurisdictions around the world, flexibility is going to become increasingly critical. I'll try to explain a little bit why in some of the slides ahead.

The third and final pillar is establishing a clear long term vision for a sustainable power sector in the future. In many countries around the world—now we're at over 160 countries that have renewable energy targets of some kind, either for the electricity sector, the transport sector, or for the heating and cooling sector. These renewable targets are one example of the ways in which governments can establish some kind of clear vision—some kind of clear framework for where the system is evolving, where we're going, what's going to be the market share of renewables in the future? And that plays a number of key roles for investment security and investment certainty as we'll see in the slides ahead.

We identified these three key pillars as some of the most basic characteristics that future power systems will have to have in order to enable a continued transition towards renewable energy, or primarily renewable energy powered system.

So first, bankability. A project is considered bankable when it provides a sufficient risk adjusted return. One thing that we noticed in really digging into this question a little bit more closely is that different investors have different expectations. So we see, for example, in the German context a lot of retail investors, or individual households, or cooperatives have quite low return expectations—sort of sub five percent. In some cases, as little as one or two

percent. And that's sufficient to attract capital and mobilize investment. Whereas, corporates, or private equity firms, or even banks that are providing loans may have somewhat higher return expectations. So I think it's important when we're thinking of bankability to ask, bankability for whom? Bankability might still make sense for an individual household, but if they can't find a bank who is also willing to provide a loan for that, then the project as a whole may not be bankable because they can't get the debt component required to finance the project. So, bankability for whom?

One of the points that we make in the report is in order to ensure that we have flourishing renewable energy market development—so diversified, active, competitive renewable energy market with high level of social acceptance, broad political support, as well as competitively priced capital. It's key to have broad participation from a wide range of different investor types, not just banks or not just corporates. I think that's one thing that we, collectively, need to put a lot more attention to in the years ahead is making sure that the policy frameworks that are developed don't just focus on one or two investor types, that they provide a foundation for broad-based investment across the market for different project sizes as well as different technologies. That's going to be critical if we're going to reach high shares of renewables in the future, not just for reasons of social acceptance, but also in terms of mobilizing all of the capital that we have at our disposal to tackle the challenges ahead. So tapping in to the capital available from different actors, from different individuals, from different entities is going to be key.

In the report, we break down the whole question of bankability into different market types. In order to keep it simple, we broke it into two—liberalized electricity markets and what are often called single buyer markets, or sort of the traditional, regulated markets with one utility buying the power. So we'll focus first on what bankability means and what it could look like in the future under liberalized electricity markets.

One of the commonalities across liberalized markets today is that there are, in most cases, virtually no technologies that are financeable purely on the back of spot market revenues. Not renewable technologies. Not fossil technologies. In most markets that have a wholesale market, prices are currently extremely low. We have a situation in most cases of excess generation capacity, both in Europe and in many parts of the U.S. Flat or negative electricity demand. Comparatively low carbon prices. We're sort of sub ten Euros a ton in Europe and have been for the last several years. Inconsistent policies, in many cases, as well as limited overall investment certainty. So in liberalized markets, because of the process that we've gone through to liberalize electricity markets, overall long term investment certainty is increasingly lacking. We've heard that from CEO's of some of the largest utilities in Europe as well as from some of the largest investors investing in renewables in these various markets, including the U.K. as well as other parts of Europe.

In liberalized markets, what are we seeing? Bankability is primarily being maintained by tenders. So currently, auctions that are tied to some form of long term agreement, long term PBA or to floating premiums. So some kind

of variation on what the U.K. is doing with CFD's or contracts for differences, or what's happening in Germany, and Italy, and other markets in the E.U. with variations on what are called floating premiums. So some kind of top up above the wholesale market price because wholesale market prices are so low.

We're also seeing a number of bilateral contracts being signed. Either bilateral with utilities or bilateral with different corporate off takers as well as synthetic PPA's, where there actually isn't an exchange of power of electricity—of electrons—but rather more of a financial agreement that a certain price will be paid for those kilowatt hours once delivered into the market and once purchased on the other side from somebody else. So synthetic PPA's are basically a way to get around the actual delivery of electricity from one party to another and more of a financial instrument to just support bankability or enable the project to obtain financing.

So that's basically what we're seeing currently happening in most liberalized markets. Where do we go from here? In the report, we try to outline this into two basic pathways. On the one hand, we're seeing new kinds of contractual arrangements. That's sort of a general category for new ways of striking an agreement for power sales. As I mentioned, we're seeing synthetic PPA's. We're seeing more bilateral contracts. We're also seeing more partial offtake agreements. So someone saying, "Instead of me selling you my ten gigawatt hours of year of wind power, I'll sell you five and then I'll sell five onto the spot market. So you're seeing these kinds of splits that we didn't really see in the past, where 100 percent of the electricity was sold to or at least ____ behind the ____ self-consumption, the electricity will be sold directly to the off taker.

We're also seeing more hedging instruments, aggregators, new business models starting to enter the market. We've captured all of that activity—sort of corporate PPA's, all of the stuff that's happening there—under new contractual arrangements.

The second main one is new revenue streams. So what are the ways that renewable producers could maybe boost their bankability or improve the bankability of the project by tapping into new revenues? We dug into that a little bit and we tried to find out, what are some of the main options available—ancillary services markets, carbon markets. In some cases, we're seeing locational pricing playing a role or emerging as well as floating premiums that compensate for current low wholesale market prices. So these new revenue streams could also help basically boost bankability in a market where electricity sales are supposed to happen primarily through the power exchange. In other words, on a fluctuating basis.

Part of the problem with the new revenue streams is that in most cases, even for combustion turbines or natural gas plants, their revenues that they can get from capacity markets or from ancillary services are still sort of in the maximum 20 percent, 25 percent range of the total revenues. And that's for some of the most flexible, rampable generation assets that we have. Renewables are going to find it tricky to really tap into those new types of

revenue streams and make them a meaningful part of their overall cash flows. I think that's one of the challenges ahead.

A third pathway that we don't consider at length in the report but I also think deserves much more concerted attention is a more fundamental redesign of the electricity market. There have been a few researchers and academics arguing for this. I think it's definitely part of the conversation, and probably part of the conversation that will need to be had as we move higher shares of renewables in the system.

So now, let's turn to single buyer markets. What does bankability look like in traditional, single buyer markets? Currently, bankability in a single buyer market is tied almost entirely to the PPA that's assigned with a particular off taker. That's the Power Purchase Agreement. In most cases, that's either a private utility or a government backed utility, or a directly government owned utility. In those cases, in single buyer markets, the bankability is almost entirely dependent on the credit worthiness of the off taker. In other words, how leveraged is it? Does it pay its' bills on time? Can it service its' debts? And can it cover its' overall cost by raising rates or by improving its' efficiencies like reducing line losses or making system investments?

So the overall credit worthiness of the off taker in a single buyer market is critical. It is the defining factor that makes investors decide whether a project is investable or not. If the off taker, whether it's S-Com in South Africa or the leading utility in Brazil, or even in key markets in China—the fundamental question is, is the off taker credit worthy, and will they pay the Power Purchase agreement on the terms that are signed in the contract, including inflation indexation and all the rest? Currency adjustments if needed. That plays the most critical, and based on our analysis we don't really see that changing a whole lot in single buyer markets. Credit worthiness is going to remain fundamental to bankability no matter how you cut it. I think a lot of the policy attention, therefore, needs to focus on derisking either the off taker or the overall investment environment that the off taker is operating in.

Curtailment rules play a key role, as well as regulatory risk and sort of peripheral, political, and economic risks. These are all factors that play a critical role in single buyer markets. So where do single buyer markets go from here? As I pointed out, broader institutional and financial derisking is likely to remain necessary in many, if not most, cases of single buyer markets. This is something that some of the folks at UNEP have been doing a lot of great work on in a number of jurisdictions with their sort of derisking framework. I think there's a lot more need for more work and effort in this space.

A second component is—and you see this in many single markets—credit guarantees, either on the loans or government guarantees on the PPA's themselves are also likely to remain necessary, again to overcome some of the credit worthiness issues with the single buyer. Again, based on our analysis, we don't see that changing significantly anytime soon in many markets. So some degree of guarantee is likely to continue to be required to maintain

bankability, especially if we're talking about large-scale scale-up in the investment market.

The third factor is PPA design itself may change, and in fact, probably will change in most cases in order to incentivize more flexibility from the different renewable generators or to provide ancillary services. So we're not just talking about a PPA sign just for kilowatt hours. PPA's may come to bundle more additional nuances in order to try to tap into more flexibility from the renewable generator. We're already seeing that in many of the contracts being signed in Europe as well as in the U.S. The ability to provide reactive power is becoming increasingly sort of common, particularly in wind power projects. So some of those things are likely to be layered into the PPA design more and more in the years ahead. So I think that's one other core change that we can anticipate in the years ahead.

And finally, it's important to keep in mind that all of this happens in a context. In order to really drive scale up in many single buyer markets, renewable targets are likely to play a really important role, especially if they're binding. In most cases, incumbents adapt too slowly to the changing market realities. If we really want to scale up—if we want to get to 30 percent, 40 percent, 50 percent, 80 percent—renewables in the mix, renewable energy targets are going to probably play a key role in that, in driving incumbents sort of in a ratcheted way towards more ambitious shares of renewables.

In order to get to higher shares of renewables, we're going to need more flexible power systems. This is another core take home message from the report, is transitioning to power shares with high shares of renewables is going to require flexibility, and much more flexibility than power systems currently have. To varying degrees, all power systems have flexibility reserves. They have these set of protocols to provide flexibility and specific power plants often designated to support system flexibility and system reliability. But this is going to grow even more as the share of PV, in particular, and wind power—what are often called variable renewables—increases.

In many cases, this is also going to require focusing more on the flexibility of demand and not just supply. So not just opening the gates at the hydro dam in order to do load following, but also tapping into some of the flexibility on the demand side. I think we're just at the beginning of the tremendous potential of demand “flexibilization” in the years ahead. I think that's going to play a key part. We try to focus a little bit on that in the report, but the main focus is really on the kinds of flexibility that renewables themselves can provide into this equation. In a lot of cases, boosting flexibility is also partly about phasing out inflexible generation. One of the main factors behind the phase-out policies that are being adopted in a number of different jurisdictions—either phase out for coal power plants or phase out for nuclear power plants is an underlying recognition by a lot of engineers and folks who work in the power sector that these assets are insufficiently flexible to be properly integrated in the marketplace.

I think in the years ahead, boosting flexibility is also going to involve phasing out inflexible generation, and that's something that we get into in the third component on establishing a long term vision for where the power sector needs to go.

This chart here captures some of the kinds of options that are available for boosting flexibility. We didn't have space in the report to cover all of these. The primary focus is really on the green category, which is what kind of flexibility can renewables provide. There's a number of different case studies for each of these three categories that gets into more detail on some of the various options that are available.

An important distinction that we set out—and this was inspired from some of the work of the folks at NREL that contributed and wrote the section on flexibility—is there are two ways to think about flexibility. The physical sources of flexibility that you have, as well as the institutional sources of flexibility. So the physical refers to the overall transmission system, the characteristics of your generation fleet, what does your fleet look like? What kinds of power plants do you have? Do you have peakers? How quick is your ramp? As well as the availability of demand side flexibility. Are there large sources of demand that can be ramped down in case the system runs into constraints or bottlenecks?

The second one, in some ways is almost more interesting than just the physical in that it refers to the institutional mechanisms that we use—that power markets use, that regulators use—to harness flexibility in the system. So there may be all kinds of—and there is—all kinds of flexibility available on the system that just may not be tapped under current market rules or under current incentive structures. I think one of the interesting contributions of the report and one of the areas more research needs to be done into is, how can the various rules and incentives governing flexibility be adjusted so that that flexibility can be harnessed more cost effectively? I think we're just at the beginning of how that particular challenge can be solved, and how this flexibility can be better harnessed in the years ahead.

A few quick words on why flexibility matters. I think it's become a bit of a mantra in the industry that as renewable investments scale up, we're going to need a more flexible system, but it's often difficult to fully appreciate quite why that is. This has now become quite a famous graph known as the duck graph. I included a little picture of a duck to capture this. And you can really see that during the rise of PV during the daytime—so between sort of 9:00 AM and 5:00 PM, you can really see that the actual load that needs to be met with additional generation declines during the day. But then as soon as the sun sets, you have a steeper ramp rate. And with that steeper ramp rate, you either need additional investments or you need to start trying to shave that evening peak in some ways. Or you need to introduce new flexibility options to improve the management of that increasingly steep ramp. This is one of the things that is likely to remain a challenge in just about every jurisdiction that aggressively pursues solar, in particular, in the years ahead.

A more extreme, and in some cases, a bit of a play on this was recently put forward by Hawaii. They've now coined the "Nessie Curve" to refer to the even steeper evening ramp that they are facing, which is captured here in the graph. It really underscores quite how dramatic the flexibility needs are in order to operate a system that's increasingly powered by variable renewables. Hawaii has recently adopted a target to move to 100 percent renewables and though they're going to be doing that with a range of both dispatchable and non-dispatchable renewables, you can appreciate a little bit through this graph, the magnitude of the challenge ahead in terms of flexibility. I think this is why so much attention is being put on this question, and also one of the reasons why we considered flexibility as one of the three core pillars of future power systems.

A similar snapshot can be seen here from Germany—it's power system. This is a forecast put forward to 2022, so now, I guess, six, seven years ahead. You can see some of the same dynamics. With the rising share of PV during the daytime, the residual load becomes increasingly spiky. We're going to need much more flexibility. In that kind of power system, we're often not far during many times of the day where basically PV and wind together basically represent almost 100 percent of instantaneous load. Once you get into that environment, you then have either the need to export or the need to curtail.

This is one of the reasons why inflexible baseload generation is increasingly mismatched from a fundamental engineering standpoint for the kinds of power systems that we need in the future. The presence of inflexible baseload is not going to be an asset. It's going to be a hindrance to achieving high shares of renewables in the years ahead. I think the debate around what we do with inflexible assets is going to become increasingly critical as we move forward. I think this is also one reason, if you focus closely on the German debate, why the phase-out of the nuclear—it's certainly not well received by all, but has been relatively well received, particularly in the renewable sector is that people realize this is absolutely necessary in order to make room for more variable renewables. Nuclear is fundamentally a comparatively inflexible generation option.

Shifting to the third on long term vision. Since power assets or generation assets have long operating lives, investors typically take a long term view of any investments they make in the power system, particularly on the supply side. This makes signaling around long term power system planning critical to the kinds of investments that take place and the sorts of investments that don't take place in a given market. So providing that long term signaling, that long term clarity is key for reducing overall investment risks. That applies both to people investing in projects as well as people investing in manufacturing and other service related installers, etc.

A related component to this is that in order to reach some of the ambitious climate and other long term targets that have been established, having some kind of a vision of where the power sector is going is critical. According to most models of decarbonization, the power system is likely to be responsible for the lion's share of decarbonization, at least in the near term, followed by

the transport sector. So we are going to—in order to reach some of the ambitious climate targets that are in place, the power sector is really going to need to establish a clear pathway to that low carbon future. Part of that is what we're trying to capture here under the long term vision.

The report breaks it down into four basic categories. Some of these we've already touched on a little bit, but we've really tried to bring this under its' own pillar, recognizing how important these aspects are. The first is setting renewable energy targets—long term targets that provide an indication of the overall market share that renewables will have in the decades ahead as well as sort of reducing the market risks associated with investing in renewable energy projects. If there's a guaranteed, binding renewable energy target, investors are more likely to commit capital to the market because they know there will be a buyer for their product in the years ahead based on that mandate or that obligation.

The second is the phase out component, so phasing out non-renewable technologies. As I pointed out, this isn't just for environmental reasons. In many cases, this is driven also, if not even in some cases, primarily by the need for flexibility. Both of these drivers are likely to play a key role in the overall discussion around phase-out in the years ahead.

The third is carbon pricing. I don't want to spend too much time on that but I think it's broadly agreed that some level of carbon pricing is likely in markets where it doesn't exist already, and in markets where it does exist, the prices are likely to ratchet up rather than down in the years ahead. So this is one component of establishing that long term vision. We don't get into the debate around whether it's taxes or cap and trade and how that plays out. But the idea of that externality is what we price. I think as increasingly being modeled into existing investment decisions in the power sector, and that's unlikely to change.

The fourth one is formulating emission standards, or what we call here environmental performance standards for new and existing plants. It's often said in the building sector that most of the buildings that are going to be standing in 2100 have not been built yet. The same applies in many respects in the power sector. Most of the power generation assets that will be powering civilization in 2070 or in 2100 have not been built yet. Hence, the importance on having more robust standards on new power plants.

All four of those components are, in our framework, essentially bundled under this idea of establishing a clear long term vision of where a government or where a jurisdiction wants to go.

A few concluding remarks and then we can kick it open to questions. The transition to a sustainable low carbon power system will be faster and easier if finance is available at scale. So if we have the large volumes of capital, large scale investments taking place at reasonable cost of capital, both for generation related investments as well as for flexibility related investments. So we need to start thinking about bankability not only for the supply piece, but bankability also for flexibility related investments. That includes a range

of the things we discussed earlier, but also things like storage, some of the new technologies that are being deployed on demand response. More attention will need to be given to how we can make those kinds of investments more bankability in order to boost the flexibility of the system in order to deal with growing shares of renewables.

A final point is that neither market type, whether monopolized, single buyer, or liberalized, are likely to sustain the kind of scale of investments. We're talking about hundreds of billions, even trillions of dollars in the years and decades ahead that are needed to really drive the kind of transition—the scale of transition that is required without policies that somehow foster a fundamental bankability, that improve system flexibility, and that provide investors with some kind of long term certainty about the overall direction we're headed in. That's one of the reasons why at the end of the report we basically conclude that contrary to many people—there's been a number of debates going on around what the future of renewable policy is, and do we still need targeted support? Do we still need policy if renewables become the cheapest sources of supply? I think one of the main conclusions of the report is, absolutely. We still need policies governing investment. We still need policies governing basic thinks like interconnection, technical standards. All of those kinds of things are going to be important and we're going to need to focus a lot more on maintaining bankability and more flexibility throughout the transition.

With that, I think I'll stop. Here's the link to the report for anyone that's interested in diving in in more detail, if you haven't found it already. We can open it up to questions.

Stephanie Bechler Great. Thank you so much, Toby. That was excellent. We've got a few questions coming from the audience, so right now if you have anything else to ask Toby, please use the Questions pane.

Our first question is cost seems to be a major factor in driving policy evolution. Could you elaborate on some of the other factors that would contribute?

Toby Couture In the framework we lay out, we identify or we frame cost as sort of the driving factor behind policy evolution. So policy evolves as a function of the cost competitiveness of renewable technologies. A related aspect is basically what's happening, for example, on the innovation front. Are there other factors? Are there other things that we haven't anticipated yet? Are there new technologies that emerged that could fundamentally change the analysis that we put forward, or even other business models that could also come in and change the equation.

One of the things that we discussed quite at length during the writing of the report that we didn't have a chance to really devote specific attention to is the rise of things like pay as you go solar. The fact that solar can be financed directly in many emerging countries, without the need for an overarching policy framework or even regulations, is significant. I think it's an open debate about whether renewables could continue to scale up, in some cases,

without any kind of policy intervention, contrary to what we lay out in the report.

Or there may be cases like in Sub-Saharan Africa where there's, in many cases, no electricity access. Is it possible that some investments can be bankable purely on the basis of customer demand and local income levels without needing an overarching government policy framework or targeted support? I think in some cases, yes, absolutely. There are cases where that is happening and the question becomes whether those kinds of trends, those kinds of patterns, those kinds of business models are going to be sufficient to really scale up and get us to where we need to go in the long term. And I think that remains open to debate.

Stephanie Bechler Great. We have another question that comes in. You briefly mentioned the possible need to complete a redesign of the power market. Given that there is an upcoming redesign at the EU power market, could you give any preliminary ideas of what you think that might look like?

Toby Couture Great question. This would require a whole webinar, if not multiple, in and of itself. Let me try to get a few thoughts out. As I pointed out, the main pathway that European jurisdictions have been using so far, at least in recent months and years, is some kind of top up—some kind of floating premium that rides on top of wholesale market prices. So long as wholesale market prices remain as low as they are across Europe, some kind of premium is likely. Some kind of top up—call it whatever you want—is likely to be needed in order to make investments bankable. That goes without saying. I think the question is, how do you design it and what are the various components of it? How complex does it get?

Another debate that's being had in the European context is, maybe wholesale prices are unsustainably low. Maybe we need to do something to boost wholesale market prices. Though as a citizen, I get a little uneasy when governments start contriving to increase prices artificially. I do think that that's definitely been discussed, and being discussed openly in the European context. What can be done to stabilize or even increase wholesale market prices, maybe even to make them more volatile—more spiky so that maybe new kinds of investments become bankable. So if you could remove price caps, for example, on wholesale market prices and make scarcity pricing sort of more credible or experience higher and more dramatic spikes, then you could perhaps target or attract certain kinds of investments and make certain kinds of projects bankable.

Again, I think that's going to be a partial solution at best. I don't thinking making soft markets more volatile is going to be a sufficient basis on which to drive the kind of transition, the kind of scale up and capital investment that's needed. We're going to need something a little more robust—a little bit more foundational than just making scarcity pricing a little more dynamic, or even a lot more dynamic.

A further factor that makes this more complex in Europe is there is a growing trend towards expanding interconnection. So Europe is moving to a more

integrated power market. That's going to mean, likely, not higher wholesale market prices, but rather, more stable or flatter, if not lower, wholesale market prices. If that's the future—if Europe continues to expand interconnections, which I fully expect to be the trend—then it's questionable whether wholesale market prices are ever going to be robust and high enough to make investments bankable.

Now, if you get down to solar at one cent a kilowatt hour, then perhaps you could see a project start to scale up and be investable. That remains to be seen, so I don't want to discount that some of the existing changes and some of the existing market tweaks might be enough in some future, but for the near term, I think some variation on a floating premium is likely to be necessary to maintain bankability, at least at the kind of scales that is needed to drive the level of investment required. It's hard for me to see another way that the level of investment required could be mobilized without fundamentally providing the bankability of those projects.

I think it won't be lost on many people in Europe, or analysts who work in this space in Europe, that renewable energy investment is largely happening elsewhere outside of Europe. Europe led the way for a few years, sort of just before and just after the financial crisis, but most of the activity now in project investment is happening elsewhere. Europe is falling behind and I think that's why this discussion around what the future of renewable strategy, renewable frameworks looks like is so critical.

I hope I've provided a few thoughts. I could certainly keep going and listing off different ideas, but I do think this is definitely a timely question and one that definitely needs more concerted attention.

Stephanie Bechler Thank you. Actually, there is a bit of follow-up to that question. Some people would like to know a little bit more of your ideas concerning what elements being the most crucial for bankable projects. You touched on it a little bit. Where do you see the most room for improvement given the current status on policies in different countries?

Toby Couture It depends on the context of—for the resource mix in some country, for example. Like in Italy, PV is already more than cost competitive with retail price. The same PV is competitive with retail prices in Germany. So there's a lot of the investment that can happen on a distributed sort of prosumer basis, either on commercial rooftops or residential rooftops, that isn't being tapped. So one area that I think Europe could certainly make a lot more progress on is trying to find more innovative ways—maybe attracting new business models or even assisting in loosening the regulatory frameworks around new business models for tapping into the tremendous potential of distributed rooftop PV, both on commercial and residential roofs.

There's also constraints in Europe around access to land, so agricultural land is, rightly, quite prized and in order to achieve high shares of renewable Europe is going to need to also make maximum use of the built environment—making use of existing areas and existing infrastructure, and also citing supply near load makes perfect sense. So the more this can be

bundled into urban areas, like in Barcelona, or Madrid, or Italy, Florence—the need for targeting the prosumer aspect of this and the role that distributed renewables can play, I think, is huge particularly given that the economics are so attractive at the moment.

Myself, in Germany, I pay roughly 30 cents a kilowatt hour for each kilowatt hour consumed. If I can do solar on my roof for somewhere around 12 cents to 13 cents on a levelized basis, that's a very attractive proposition. I just need a business model that's going to help me unlock that. There is innovation happening on this. There are important signs of that starting to take place. So I think a part of the challenge can be solved through the distributed pathway, as I've discussed with the rooftop distributed route.

But when we're talking about larger scale projects—larger scale wind, onshore wind, larger scale solar—I think the challenge for bankability becomes more critical. One option that's being discussed or that is currently being implemented, to some degree, in the U.K. is very generous inflation indexation. So you start with a very low nominal tariff that may seem to be sort of fairly cost competitive with existing wholesale market prices, but with a fairly generous indexation. So basically, under that kind of inner approach, you're basically back loading the cost by indexing the tariff over a longer period of time. Countries like Germany have traditionally not offered inflation indexation.

In most cases, the inflation indexation wouldn't need to be very generous in order to attract investment because interest rates are at historic lows. Investors are looking at anything that will provide a sort of reliable long term yield. One of the ways that I think that could be done is a combined strategy around inflation indexation, so thinking more carefully about how the various offtake agreements can be indexed in order to still secure that bankability. So even if your nominal price starts off quite low, it escalates and that may provide a way that bankability could still be achieved. Fundamentally in the long term, that will decouple it from wholesale market prices and that may become unsustainable in the future. Again, there's an inherent possibility that wholesale market prices are set for a period of sort of eternal suppression.

There are some energy economists out there who think that wholesale market prices are going to magically bounce back once we get better carbon pricing and we phase out existing fossil or nuclear generation. I tend to think that unless you can really phase back, we're talking 50 to 100 gigawatts of capacity in the years ahead, it's going to be difficult to see wholesale market prices recover in a meaningful way. I tend to think we should rather accept the reality of lower wholesale market prices. This is what Jeremy Rifkin calls the sort of zero marginal cost paradigm. The electricity system is increasingly moving towards a zero marginal cost paradigm. I think we need to redesign or rethink the way we achieve bankability of capital intensive assets under that kind of an environment.

As I pointed out, there are no easy ways to do that. Counterintuitively, we may actually move back. Another possibility in this space would be to move back to some of the early kinds of policies that were used in the 1970s and

1980s, that offered basically a capital investment subsidy to just buy down the capital cost. In some cases, if you covered, say, 30, 40, 50 percent of the capital cost, then the renewable energy project may be bankable from a purely wholesale market price basis.

This is effectively what the U.S. is doing with production and investment tax credits. The investment tax credit shaves off 30 percent of the cost up front. If you add depreciation provisions, you get close to 50 percent. So the U.S. is essentially, through the tax code, slicing almost 50 percent of the cost of a renewable energy project off at the beginning and then allowing the project to sell its' power to whomever it wants or on to the wholesale market.

A similar approach could be deployed, as much as its' been criticized in the past in the U.S. as being vulnerable to congress and all the rest—again, it's a controversial thought but there may be an insight there. There may be a way that could provide a pathway to secure bankability. So if you provided some kind of investment tax credit, then the upfront cost of the investment could go down and you could make it financeable or bankable on the back of wholesale market prices.

One of the downsides of that is that you lose in the diversity of investor types. Who can participate? Who has large tax liabilities? And then you see a concentration of the investment market come on those who have large tax liabilities. This is exactly what's happened in the U.S. There may be more intelligent ways that Europe can do that that avoid some of those negative while tapping into some of the positives, so sort of the fiscal route—the fiscal policy oath to achieving bankability.

I could go on, but that hopefully provides a few additional thoughts for the time being. If anyone wants to discuss this further, I'd be glad also to have a discussion by phone or follow up after. You can find contact details on my website.

Stephanie Bechler Excellent. I'll shift the conversation away because I know we can keep going. Given that the existing power infrastructure supports fossil and nuclear power, how big of a hurdle is it creating a renewable energy policy given that the current economic and political power of fossil fuel companies and their interest in maintaining the way things currently are?

Toby Couture I tend to take a different reading on that. I think if you look at what's happening in the U.S., coal companies are going bankrupt left and right. In Europe, the large utilities—the large incumbent actors that were essentially the feudal lords of the previous electricity system—are now posting annual losses in the billions. We are in a radically different power environment than we were even a decade ago in relation to the power system—even a few years ago in relation to the power system.

So I'm actually more optimistic on that front. I think—what is it John Maynard Canes once said, that the power of vested interests is often vastly overestimated versus the power of ideas in history. I tend to agree. I think though there are very real power interests—there are very strong incumbent

interests in the power sector as there are in any sector—I do tend to think that if you look at trends in recent years in the coal and in the nuclear sector, let alone natural gas sector and natural gas plants. Europe has mothballed something on the order of 40 to 50 gigawatts of gas Europe wide in the last six or seven years. So we've seen a lot of power being disrupted in recent years of renewable energy scale up.

The question is, and I think part of the underlying debate in Europe is it seems that that has shifted now and that the—it's kind of the empire strikes back. There's a reassertion of the conventional utility thinking and conventional utility logic around controlling the pace of renewable growth and scaling back policies. I do think that's a very real part of the debate so I don't want to downplay it. I do think that it's a very real factor and we see the impacts of that on the renewable investment landscape in Europe. I think if you take a broader step back, the trends are still definitely globally in the right direction.

Stephanie Bechler Thank you. Along those lines, many IMBC's are taking nuclear as part of non-fossil fuel energy. Do you have any other suggestions on how those countries should meet their energy demands, if not nuclear?

Toby Couture Yeah. The problem with nuclear is that it isn't cost competitive and it never—if you do true accounting—it never was. The hope was that nuclear would come down in cost and that it would become cost competitive. But nuclear is the only generation technology in history that has become more expensive over time rather than less as the market has developed. I don't see any signs of that changing. If you look at recent nuclear reactors that have been built or are being built, the trend is definitely in the other direction. It's towards getting more and more expensive and finding a harder and harder time to attract investors. Nuclear plants, if rate payers interests were respected, we probably wouldn't see another nuclear power plant built anywhere in the world because there are cheaper and more cost effective ways of moving to a low carbon path than investing in nuclear. So I broadly think that wherever nuclear is being built, it's fundamentally a regulatory failure. If regulators were doing the job of protecting rate payers, it would never get built. It would never get approval because it's quite obvious to anyone who is paying attention that nuclear is not cost competitive.

So I think, should nuclear be part of INDC's? In my view, we should be trying to maximize the amount of impact with the finite resources that we have. So if we have 10 billion dollars or 20 billion dollars to invest to achieve our nationally determined contributions, we should be trying to maximize the impact—maximize the reductions from that. And on any fair accounting of emissions reductions, nuclear is one of the most expensive ways to reduce emissions, both in the near term and in the long term. It does not even begin to compare to other ways of reducing emissions.

I think any government that's thinking seriously about investing in nuclear at the moment, especially if climate is being used as an argument, they need to go back to the data and really look at what the most cost effective ways of reducing emissions are. Nuclear wouldn't even stand a chance against

efficiency—wouldn't even stand a change of doing something about clean cooking—wouldn't even stand a chance against a host of other measures, including renewables.

That's my thoughts in a nutshell on that. I broadly do think that investors have already caught on to this. It's very difficult to find any private investor who is willing to invest in nuclear. I think the bond markets are also going to look increasingly unfavorably on governments that try to finance nuclear plants on the back of the tax system basically by plowing their own money into it because of the risks around cost overruns—the uncertainty that poses fiscally as a fiscal risk for the government. Anyone in finance who is paying attention—anyone in the energy sector who is paying attention should recognize by this point that nuclear is not cost competitive and is not the best way to reduce emissions. I probably went on a little longer than I should there, but hopefully that is helpful.

Stephanie Bechler Great. Someone wants to know, what are your thoughts on the EU's state aid guidelines? Do they reflect a move towards phase three of this policy evolution driven by cost, or rather, an attempt to bring everyone up to phase two?

Toby Couture Interesting. I think the state aid guidelines has a complex history. It's probably caused more harm than good insofar as the renewable energy sector is concerned. I think it's probably done a lot of good on balance in terms of limiting the ability of governments to do things they probably shouldn't. But in relation to renewables, I think the state aid guidelines have probably—and again, I should preface this by saying I'm not an expert in the state aid guidelines. But they've probably overstepped their bounds and have made it increasingly difficult for governments to design the kinds of policies that are going to help achieve a low carbon system in the future.

I'm of the opinion I think the state aid guidelines—provisions should be made to establish clear, if not exemptions, clear provisions governing renewable energy or low carbon related investments, recognizing the strategic importance of decarbonization globally as well as in the European context. In many cases, the amount of time and effort and essentially the opportunity cost—the lost time of having to navigate or negotiate—the state aids has really cost Europe quite dearly.

For anyone that's not in Europe, this probably sounds quite esoteric, so I don't want to spend too much time on this, but in my view, I think the state aid guidelines have definitely caused more harm than good in the renewable energy sector and need to be revisited or rethought with an eye to the strategic interplays that are at stake. We need to be transitioning to a lower carbon system, and for that, I think in many cases governments are going to need a bit more latitude than the current state aid guidelines provide.

Stephanie Bechler Excellent. That is all the time we have for questions right now. If anyone listening still has another question they'd like to ask, please submit it and we can always send those out to be answered later. Toby, do you have any closing remarks before we begin the survey?

Toby Couture No. I think, generally, the effort in the report is really to try to capture where we are and also to provide an indication of where we might be going. I don't think there is anything definitive. This is very much an ongoing conversation. We tried to provide indications of where we think things might trend, but I think perhaps more important than that is the overall framework that we set out in terms of understanding the evolution of policy, understanding their continued need for a basic policy framework that supports bankability and increases flexibility. I think that really is valuable and I hope that other researchers, other analysts, other policy makers can find that useful, as well.

Stephanie Bechler That will move to our first attendee survey question. The webinar content provided me with useful information and insight. You can select Strongly Agree, Agree, Not Sure, Disagree, or Strongly Disagree.

Thank you. And now we'll move on to the next question. The webinar's presenters were effective.

Our third question—overall, the webinar met my expectations.

Great. And our fourth question—do you anticipate using the information presented in this webinar directly in your work and or organization?

Thank you. And our final question—do you anticipate applying the information presented to develop or revise policies or programs in your country of focus?

Great. Thank you all so much for answering our survey. On behalf of the Clean Energy Solutions Center, I'd like to extend a thank you to Toby and our attendees for participating in today's webinar. We've had a terrific audience and we very much appreciate your time. I invite our attendees to check the Solutions Center website if you would like to view the slides and listen to the recording of today's presentation as well as any previously held webinar. Additionally, you will find information on upcoming webinars and other training events. We are also posting the webinar recordings on the Clean Energy Solutions Center YouTube channel. Please allow about one week for the audio recording to be posted. We invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including our no cost policy support. Have a great rest of your day, and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.