

Power Systems of the Future

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Presenters

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This Transcript

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Sean

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 the 21st Century Power Partnership, also known as 21CPP. Today's webinar is focused on the recently released 21CPP report, which was titled Power Systems of the Future: A 21st Century Power Partnership Thought Leadership Report.

One important note of mention before we begin 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.

For the webinar features today, you do have two options for audio. You may either listen through your computer or over your telephone. If you do choose to listen through your computer, please go to the audio pane select the "mic and speakers" option. That will just help eliminate any feedback and echo. If you dial in by phone, go to the audio pane and select the telephone option and a box on the right side will display the telephone number and audio PIN that you should use to dial in. Just a reminder panelists, please mute your audio devices while you are not presenting. If anyone is having technical difficulties with the webinar, there is GoToWebinar's Help Desk number that you can

contact. That is displayed at the bottom of the slide and that number is 888-259-3826 and they can help you out there with any issues.

We do encourage anyone from the audience to ask questions throughout the webinar. If you do have a question for the panelists, we ask that you type it into the “Questions” pane in the GoToWebinar window and submit it there and then we will present those to the panelists during the question and answer session following the presentations. If you are having difficulty viewing the materials through the webinar portal, we will be posting PDF copies of the presentations to cleanenergysolutions.org/training and you may follow along as our speakers present. In addition, an audio recording and the presentations will be posted to the Solutions Center training page within about a few of today's broadcast and it will also be added to the Solutions Center YouTube channel where you'll also 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 presentations from our guest panelists Dr. Douglas Arent, Barry MacColl, and Efrain Villanueva. These panelists have been kind enough to join us to discuss the recently released 21CPP report, Power Systems of the Future, including presentations on power sector transformation pathways in Mexico and South Africa.

Before our speakers begin their presentations, I will provide a short informative overview of the Clean Energy Solutions Center Initiative. Then, following the presentations, we will have a question and answer session where the panelists will address questions submitted by the audience, followed by closing remarks and then a very brief survey.

This slide provides a bit of background in terms of how the Solutions Center was formed. It 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 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.

There are four primary goals for the Solutions Center. The 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. Third is to deliver dynamic services that enable expert assistance, learning, and peer-to-peer sharing of experiences. And then lastly, the Center also fosters dialogue on emerging policy issues and innovation around the globe.

The primary audience for the Solutions Center 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.

This slide talks a little bit about one of the marquee feature that the Solutions Center provides, which is its 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 each available to provide remote policy advice and analysis to all countries at no cost. For example, in the area of Regulatory and Utility Policies we are very pleased to have Riley Allen, Research Director at the Regulatory Assistance Project, also known as RAP, serving as one of our experts. If you have a need for policy assistance in regulatory and utility policies, or any other clean energy sector, we do encourage you to use this valuable service. Again, the assistance offered is provided to you free of charge. If you have a question for our experts please submit it through our simple online form at cleanenergysolutions.org/expert, or to find out how the Ask-an-Expert service can benefit your work please feel free to contact me directly at sean.esterly@nrel.gov or at my number at 303-384-7436. 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 panelists. Our first speaker that we’ll be hearing from today is Dr. Douglas Arent. Dr. Arent is Executive Director of the Joint Institute for Strategic Energy Analysis at the National Renewable Energy Laboratory [NREL]. He specializes in strategic planning and financial analysis competencies clean energy technologies and energy and water issues, as well as international and governmental policies.

Then following Dr. Arent, we will hear from Barry MacColl. Barry has been working in the power industry in South Africa for over 23 years. He is currently the National Utility’s head of Research, Testing and Development and leads a team of over 400 people involved in applied research, testing and consulting in a variety of specialist energy technology related disciplines.

And our final speaker today is Efrain Villanueva. Efrain is General Director of Clean Energies at the Ministry of Energy in Mexico.

And with those introductions, I would now like to turn things over to Dr. Arent for the webinar.

Douglas

Greetings everyone. Thank you Sean for the introduction. Let me just double check that the slides are working well for everyone.

Sean

Yep, we can see them up on the screen.

Douglas

So I'm going to try to go along relative quickly to provide some highlights and overview of both the 21st Century Power Partnership and our most recent paper that we released with many co-authors from around the world as we get through that. Let me just talk about the Power Partnership.

As Sean mentioned, the Clean Energy Ministerial has 13 initiatives and this is one of them—one of the more recent ones. It was launched in 2012 at the London meeting of the Clean Energy Ministerial and was really set up to be a cross-sectorial initiative looking holistically at power sector transformation to incorporate the major trends integration of renewables, increasing intelligence in the power system, as well as the efficiency in demand response, and to take those elements together in a holistic perspective of policy and regulatory best

practices, sharing, and thought leadership to help among all of the partner countries, which there are many in the Power Partnership today and will appear from two of our colleagues in more detail later today.

The Power Partnership itself really focuses on four elements. The first is, of course, sharing—developing and sharing knowledge. The second is to strengthen the disseminating technical tools. This includes policy and regulatory analysis, the power sector planning, and operational tools, a significant amount of capacity building through peer-to-peer exchanges, as well as workshops and networking events. Then, lastly but not least, really establishing partnerships in a multi-lateral framework among all of the countries and others who can offer technical expertise to the partnership and countries to deal with questions that they're facing and would like some help on.

The partnership itself is organized in a very streamlined way. We have a steering group, which incorporates the steering governments as well as organizations from civil society and private firms that help guide the annual program of work. That program of work is supplemented by input from a public-private leadership forum, which is really bringing the voice of the private sector into the policy and regulatory dialogue, particularly relative to technology change, as we'll hear about later in the hour here. Then, the NREL and the Joint Institute serve as the operating agent and we partner with a very large conciliation of international experts to bring forth both the thought leadership work, for example, what we'll present today, but also bringing together the network of experts to offer the peer-to-peer exchange and capacity building.

On to the topic of the day, we released a report most recently called Power Systems of the Future. It's part of a series of Thought Leadership Reports that we have released over the last few years. We had 17 contributing authors from around the world on this and we're very pleased with the outcome. I think the real question that came to ourselves from the leadership group and the steering committee was can we provide a framework for colleagues, analysts, policy makers, and leaders to understand how power sectors are evolving and can evolve over the next coming decades. To start with, the most important element was to take a holistic approach. Here you see, of course, only one diagram that tries to capture many of the different elements here but clearly power sectors are very complex systems of systems, which include the policy, the regulation, of course dealing with many many different types of customers, the technology landscape is evolving quite rapidly, as well as business models needing to adapt to that changing dynamics, and, of course, the policy and regulation formulates those markets. So, we need to be cognizant of all of these elements as we think about a holistic change and the direction of power sector transformation as that evolves.

There are principally 10 different trends that we articulated that are driving power sector evolution here. To read them very briefly: certainly renewable energy cost reductions; data and intelligence; security and reliability goals; evolving customer engagement, including really looking toward value

propositions of the customer; the tale of two electricity demand forecasts refers to growing growth of electricity in the emerging markets and principally flat or decreasing demand in relatively mature markets; increased interaction with other sectors includes transportation and the thermal sector, particularly there are some very interesting linkages with water in the energy-water nexus realm as well as electric vehicles; local air emissions will drive change and is driving change in some markets, but not all markets; energy access, of course, remains an imperative in many countries and that should be taken into account as one thinks about the landscape of evolving power sectors; and diverse participation—here it means that there is an increasing heterogeneity from vertically integrated potentially single ownership from generation through transmission and distribution to many different market players offering solutions in those markets; there are both revenue and investment challenges but clearly market opportunities for those diverse players in markets where it is appropriate and it is allowed. I think the takeaway here that's written on the bottom of the slide is really important. It means that really to take into account all of those dynamics in your market situation and be very mindful in terms of deliberate and proactive collaboration to put forward planning and transformational change to achieve the desired outcomes of all of the stakeholders.

Within that context, what we came forward with was a framework for decision making. I think this is a very important place to start, which is to understand where you are at today and then how much change can you or do you desire over what period of time. Here you see a very simple 2x2 matrix that tries to capture that. It's an adapted from the book that's referenced on the bottom. Clearly the evolution, that a path that is chosen, is dependent upon technological, financial, and institutional legacies. Those with heavier legacies, i.e. the developed markets that are mature, there is a trend toward what is called cautious incrementalism, though there is a definitive push toward more evolutionary and even revolutionary change. Then, in markets where there are "lighter legacies"—there is the opportunity for more rapid change but I think that those generalities don't hold in every market. It's just a general observation.

More importantly I think what we try to do is evolve and map the literature of the transformative power sector scenarios that have been describe or are in process into this framework. Here you see the initial mapping of this where some of these acronyms may or may not make sense to you but I'll refer you to the report for some details but there is heterogeneity here, again, where in some instances there is some rigidity toward change. This is the BNEF fight, for example, or compare that to, for example, the revolutionary scenarios, which are described in the Rocky Mountain Institutions' description of grid defection where, for example, they are really pontificating an idea where significant amounts of distributed generation can go forward and evolve the power system quite dramatically. We're going to hear some examples from our colleagues later, particularly about the Mexican reform and what's happening in South Africa, to describe two particular ones and how they fit in this framework.

I think interestingly, looking at a couple of details, what you see here is the mapping of a few of the evolutionary scenarios as they've been described. The one in particular, RIIO, if you're not familiar with that, is from the UK. It translates to or evolves from revenue = incentives + innovation and outputs. It's really an example of performance based regulatory reform oriented toward four key outputs. One is to put stakeholders, i.e. customers as well as the utility industry at the heart of the decision making process, invest in efficiency, innovate to reduce network costs for both current and future consumers and then play a full role in delivering low-carbon economy and wider environmental objectives. So you can see very clearly there the elements that we spoke of earlier in terms of engaging customers, including technology, thinking about the environmental aspects, as well as assuring reliability and affordability. Each of those comes forward in that example. They come forward and are articulated in other examples as well that I won't spend time on here, but you can read about it in the report as we go forward.

I need to move along relatively quickly. There are 10 elements that are really focused here on investment trends. I won't read through these. I think very importantly these were looking at four are bringing new investment into the sector. I think most critically this is all related back to the health of the off-take agreements, the health of a project developer in terms of assuring revenue sufficiency and viability of the project, bidding into a particular market, or the off-take viability of an off-take agreement in terms of the balance sheet and how the finances of that particular off-take party are implemented or affected by these various aspects. Of course, all of those are deeply connected to the policy and regulatory environment.

Let me talk very very briefly about pathways going forward. What we tried to do here was to map out essentially a set of pathways thinking about adaptation, evolution, reconstruction, or revolutionary pieces. You see them listed on the left. Next gen performance regulation—so RIIO as an example of that. Clean restructuring—we'll hear from Efrain about what's happening in Mexico there. Unleashing the DSO—DSO is the distribution services operator. That's really a generalization of what's happening in terms of the transformation in the New York market, which is being driven by Richard Kauffman, one of our co-authors there. Then there are two different ones related to the bottom of the pyramid—energy access that I'll describe very very briefly before in a few minutes.

Also very importantly is to think about where you're at and how that helps inform which pathway may be more viable or more easily implemented. Here we show a very simple mapping from three particular present status structures: vertically integrated, restructured market, or low energy access. What those tend to drive to in terms of what the viable or next potential path is. It's not a one-to-one mapping but it gives a sense of if one were to begin a transitional pathway or start thinking about that, what might one want to include in terms of those elements going forward, but certainly a combination of those may actually be viable in your own situation.

That performance-based generation, as I talked about from the RIIO example, includes these main elements. I think it's very important to think about stable but adaptive policy and regulatory change that is oriented toward value. A delivery of value is very different than rate of return based policy and regulatory environment, which many of us are used to thinking about. Then, thinking again increasingly that earnings are linked to quantifiable performance metrics over long performance periods. The long performance period here is very important because of the nature of the high cost long-live assets, which are in the power sector. I encourage you to read through those in quite some detail in the report.

This one I'm only going to very very briefly describe. Efrain will describe it in detail. It really maps out the transitional pathway in Mexico and so I'll defer to him to talk about in more detail.

Then, as I mentioned, the DSO pathway that's the distribution services operator really is trying to incorporate a wider variety of value-based services and to include much more customer facing organization and enable that as it's mapped out on the right. It also includes a very much appetite for technology neutrality in the policy and standards, again, incorporating performance-based value based policy and regulatory decisions and encouraging technology and business solutions innovation, bringing value to the customers. There are many elements of this that are mapped out on the right hand side and they interact back through into the transmission system but the bulk of the innovation is on the left hand side of this map on the right hand side of the slide as you see it.

A couple quick slides just to talk about the bottom of the pyramid, a very important part of power sector transformation in many countries around the world. Here we talk about two different particular pathways. One, of course, which the arrow points to, which is bottom up coordination of grid expansion, this is a hybrid between community based services and top down expansion. It's got the elements, which are listed on the left hand part of the slide in terms of technical and regulatory backwards compatibility of "mini-grid" solutions, ratepayer or private financing for mini-grids, and assurance of how those mini-grids will integrate with a top down grid expansion as it goes forward. That contrasts slightly with a bundled community energy planning pathway, which is a bit more hybrid in terms of mini-grid in combination with distributed generation, which might be anything from solar home systems or hybrid systems for homes and communities. There is a clear regulatory pathway that leverages the innovation and the scale, the small scale of this pathway, to allow it to evolve to the other pathways and become part of a holistic solution as it goes forward over time.

I think, very quickly, I tried to summarize the thought process as we've gone through the mapping of the power systems of the future and how that may evolve. You'll see in the next couple of presentations some specific examples of this but I think most importantly that in each of these it's really the holistic approach to take into account that allows one to think through a

transformational pathway that's both adaptive as well as predictive to assure that the financial viability of the system goes forward.

So with that I just encourage you to look at the resources, which are available on the 21st Century Power Partnership website and to contact us at 21stCenturyPower@nrel.gov if you have more questions or comments. Sean I think I turn it back to you at this stage?

Sean

Yes, thank you Doug and we can actually move right on to Barry for his presentation.

Barry

Thank you very much Sean. Barry MacColl. Good morning to you. Good afternoon to people on this side of the world. It's really good to be a part of this. I've got Heather driving the slides for me so I unfortunately have to say "next slide" occasionally. I know that will be annoying for some of you but please bear with us. Doug, great to hear your voice. Hopefully we can hook up soon. We're always pleased to work with you guys.

I work for Eskom, which is the power utility in South Africa. It's been the power utility for 90 years. A lot of these slides are Eskom slides but many of them don't just look at Eskom's view. It's upfront to give an overview of South Africa as a country, rather than just our views as a utility. Our challenges in South Africa are quite vast as you can imagine trying to power a first world economy in a third world situation. It has a lot of balancing that needs to be done. We're having difficulty at the moment in providing capacity, keeping the lights on and powering the economy.

The economy has grown by about 79% since 1994, which was our independence, but the power capacity hasn't kept up and so at the moment, we're very constrained and I'll show you a picture of that later. Carbon is a big issue for us as Eskom. We're the 13th biggest emitter of CO₂, over 220 million tons of CO₂ last year. We're predominantly a fossil-based utility, using coal as our primary energy input. We still have a large poverty gap in South Africa and southern Africa. Figure 3.5 million households without access to electricity still in South Africa, although we've done work over the years.

Affordability and competitiveness in Africa will always be an issue in the protection of the poor in trying to figure out what people can pay and will be able to afford and also impacts on the environment and system stability. I will touch on two of the acronyms at the bottom there, which is Independent Power Producers or IPPs and also lead into the next slide please, which is the Integrated Resource Plan for South Africa.

The Integrated Resource Plan 2010, as we call it, was put together way back in 2010. There is a later document, which I'll refer to, which is currently being developed. The interesting take on our Integrated Resource Plan, which is really the document you need to go to I think first if you want to understand the plan for the reform of South Africa. It is a very bottom up negotiated document involving many many players over many many months. We ended up with a revised balanced scenario, which looked at several cases. We

settled on a base case that, after a second round of consultation, was criticized quite dramatically and the main changes that we made were an increase in the nuclear costs. We changed some of the lending rates of the technologies and we disaggregated solar technologies between PV and concentrated solar. You may know that South Africa is blessed with some of the world's best solar, so getting the solar planning right is absolutely key.

After the consultation process between 2010 and 2011 we finally ended up with what is called the Policy-Adjusted IRP, Integrated Resource Plan. That's one that I'll take us into some detail on in the next slide please.

So South Africa, coming from a very base of coal, predominantly coal over the last 90 years, is now going through...it's interesting. Doug, when you put your four quadrant matrix up and I'm trying to determine the speed of our change and the extent of our change, it's quite difficult for me to make up my mind as to where we fit in the matrix but the pace, in my opinion, is quite fast. This is what the capacity additions will be to the country up until 2030 in gigawatts.

You can see there is still some planned capacity increase for coal. South Africa still has a nuclear ambition. There is a large amount of nuclear but I think let's fast forward to the right hand side there's 17.8 gigawatts planned and I'll give you some progress feedback just now on solar PV, CSP, and wind in the country, which would take us from no percent renewables to about 9% renewables in 2030. The current base at the moment is about 44 gigawatts. Next slide please.

This is what South Africa's energy mix would look like in 2030. Take some time to get to understand that some of the existing coal plants would be decommissioned in this time. On the right hand side you can see baseload coal, which is existing; some is commissioned and some is decommissioned and some is new. A large portion of renewables are at the top left hand side of that pie chart and quite a large amount of nuclear down at the bottom. What's interesting for us is that South Africa, if the plan comes to pass, which believe it will. To a greater or lesser extent South Africa is moving from an economy, which is predominantly coal based; 90-92% of our energy comes from coal to 1 in 2030, which is only 46% based on coal declining. This is major shift in our economy and a move towards a cleaner energy future. Thanks, next slide please.

The renewable energy program has got a quite a fancy acronym, The Renewable Energy Power Producer Program should have three Ps on the end. We've just finished round three of that. There were 93 submissions. It's not a refit program. It is a building program and it goes through in rounds. As I've said, we just finished round three. We selected 17 of the 93 bidders and that brings in total the number to 64 successful Independent Power Producers. Independent from Eskom. Independent from the national utility that have one grid in solar and in wind and I'll show you the breakdown there. What's interesting about that is it's based specifically on price increases; there has been a definite price decrease across all technologies. Wind, for example has dropped from 1.14 rand per kilowatt-hour to 74 cents through a competitive

bidding process. Solar PV has come down from a whopping 2.75 in window one to 99 cents per kilowatt-hour in window three. The solar for rand is about 12 rand or about \$42 USD at the moment, so you can do that math there. Then window three also saw the addition of some biomass and natural gas projects as well as linear Fresnel CSP technology, which also makes its debut in round three. Next slide please.

This is a summary of the impressive progress on the Renewable Energy Independent Power Producers Program. If you just add up the three totals in the first three columns it comes to almost 3.9 gigawatts of capacity allocated in South Africa over a reasonably short period. The plan was promulgated in 2011. This program has only been running then for about 4 years and many of these projects are actually up and running already. What's also of interest on this slide, and it's my personal opinion but many in the wind industry disagree with me, is that solar PV seems to be making inroads into the wind market. I think that is because the wind projects that were easy to commission and we have great resources for have been largely snapped up, but the sun in South Africa falls just about anywhere. The land availability of the access to the grid on the solar PV projects is starting to encroach on the wind projects. Next slide please.

One of the challenges that we face is the access to the grid and I also would like to refer you to a document, which is free to download if you are interested in the South African grid. This is the Generation Connection Capacity Assessment of the transmission network. As Eskom, the company I work for, we are the consumer/buyer of this energy and we're also the owner of the transmission network. We're often criticized as being a bottleneck for growth of the Independent Power Producer Program. We don't disagree with that but we think the motive is not always communicated. In many respects the wind and solar projects that are coming on streamline in areas of the country where, to date, there has been very little economic activity. The same for South Africa, for example, there is a large sunny area called Koru. There's very little development in Koru but now we have a whole bunch of solar developers wanting to develop solar farms there and the transmission grid just doesn't exist. Here we are doing a large amount of work on good expansion. I believe this document would give you insight into that. Next slide please.

This is just an indication of the price decrease that has been affected. I've already mentioned it specifically in wind and PV in the various bid windows. Along the x-axis is bid window 1, 2, and 3. You can see that as time going forward. On the y-axis is basically the cost reduction of the wind projects in South Africa in either 2011 or 2013 rounds, whichever you would choose. The drop has been substantial both from a technology price reduction but also we believe through a competitive bidding process. That trend is not expected to continue linearly downwards but we do believe that rounds 4 and 5 that are being planned will see further reductions.

Just for your interest, on the y-axis the average price of 1,000 rand per megawatt hour equates to about 1 rand per kilowatt-hour, which is probably the price that its typical end user pays for electricity in South Africa. Round

three has produced grid parity for PV and wind in South Africa and obviously that is much to the delight of many people, myself included. That's the case of now taking that forward into the planning for the country. Next slide please.

This is a very busy slide. I will skip through it quickly but this more the way forward. There is an update on the 2010 survey. The IRP 2010 is now being revised again. In my opinion it's a far more flexible plan than what was on the left hand side, which is, as I said, what we called the IRP 2010, the policy adjusted scenario. We're now getting into a situation where it's very difficult to predict the future in South Africa and, I think you would agree the world at large. So the plan needs to be a lot more flexible and so we're building in demand forecast trajectories in phase 2 and also test cases in phase 3, which is the green phase on the right hand side. Those test cases allow us to adapt the plan to various different issues in the country. If you look at the top right hand side of that green block you would see the scenario of big gas. Big gas is something that we are still examining in Southern Africa. It hasn't generally been available to us but there is very exciting shale gas developments taking place in the country. There have been delays slightly by the low oil prices but I do believe they will come back with a vengeance and so does big gas play a role in the future of South Africa? The answer at this stage is we don't know but we need to be able to have the flexibility to adapt. So what's nice about the plan going forward is that it is an adaptable plan to gas, fuel price sensitivity, nuclear costs sensitivity, etc. and I think I'll touch on that in the next slide.

So, if you look at...let's not look at both graphs. I could spend a lot of time on this but let's look at the bottom graph where it's been chopped off slightly, which is the revised balanced scenario. Those are the years going forward to 2030 and this gives you a good indication if, for example, you look at coal, which is the black area of the bar chart. There are initial investments in coal in South Africa right after 2020. We also close two very large coal factories in South Africa. Going forward from 2020 onwards it's more about decommissioning coal than commissioning coal. We can see the nuclear bill program there in red. We can see other renewables in various shades of green and gray. The document, if you are interested in reading it, is also publicly available and it's full of graphs like this. Depending on what scenario there is in South Africa these graphs will come into play. Honestly these technologies have a large lead-time so you need to have a little bit of a forward look into the future, but it is definitely something that is more flexible than the previous plan. Next slide please.

The next slide touches on the demand full cost. I think, Doug, you mentioned that demand is one of those big uncertainties in any market reform. You can see on this graph that in South Africa, if you are an optimist you believe that growth, economic growth, is the little light blue block in the middle of the three blocks there and there are various scenarios presented. If you're an optimist in South Africa and you believe that Africa is a growing economy and that the need to reduce poverty will overrule any other negative strengths and growths, you could have a 5.4% growth. The lowest full cost, which we've called weathering the storm, the green line at the bottom, only predicts

a 2.3% growth forecast for South Africa. Even some people say that that is optimistic, for example, IRP growth in the country this year, January to January, was -1% so it's not just developed countries that are facing a stagnant demand for electricity, but it would appear also that ourselves. Would you go to the next slide please?

What's also a big variable for us is the technology cost assumptions, which we put into the plan. What I love about these cost assumptions is that they are always wrong and people will take great delight in telling you that they are wrong. We know that these costs are open to scrutiny. We love to work with people in the 21CPP and NREL to develop these costs internationally. The land development costs in a country are different but international trends are hard to buck. What's good about this little graph is that it shows the cost differences between the IRP update, which is the plan that is currently being revised, and the IRP 2010. The little red dots are the current process as we would see them and the dark gray bars are where the prices were in 2010. Some things have gone up in price. Where, if you look at PV and wind, it's gone down in price below inflation. If those trends continue then it's obviously good for wind and PV, not so good for nuclear and, at this stage, CSP. That indicates that we need to have a flexible plan because these cost assumptions are very...there's a lot of leverage of the cost in the plan. Next slide please.

This slide is the basically around technology choices. If you don't mind I'll skip this slide. It pretty much says the same as the previous slide with a little bit more detail and touches on the learning curve and also something that we would like to understand and is the learning curve of the various technologies because obviously the plan is very price sensitive. This is an interesting graph in terms of...depending on the load forecast indicated by the dotted, dashed lines are the various load forecasts going forward. Then the document that I referred to IRP revised document, which I encourage you to read if you are interested, that has various scenarios. This is just one of them that then shows in little circular form the investments that then are required to meet the demand. So, depending on which scenario you want to follow you could see there the nuclear investments in red and the coal investments in brown, etc. As I said, as the economy changes, as the markers along the road change, so the investment decisions change. We, as a utility, are finding it very difficult to be flexible enough to adapt to changing conditions because the investment decisions for many of these plants need to be made 5 or 6 years prior to the actual first concrete and that's proving quite difficult. Next slide please.

The next slide is a similar discussion but focusing more on the wind and PV under the different scenarios. I'll leave you to study that on your own but in a high nuclear scenario, for example, you get a lower amount of PV and wind invested. On a low carbon scenario you would get higher amounts of PV and the document is full of these types of scenario. The graphs, which would take a little bit too long to explain in a web cost like this. Let me just move to the next slide, which you can just flash and then go to the one after it.

This is now...I think it's interesting for you to understand, perhaps, recent developments in South Africa and what is happening. In the introductions we were talking about rapidly changing dynamics in our market the one thing that has been very rapid is that I mentioned earlier that we have capacity shortages in our country. We also have these large two coal projects, which are running over time and over budget and our government is getting very frustrated with this and has decided that the country needs a war room. It's their term, not mine. A cabinet...our government has set up a War Room in our government buildings and that War Room is now starting to oversee all the functions of the electricity supply in South Africa, but I must admit more with a near term operational and technical focus than a strategic focus.

On the next slide we will see that the War Room is busying itself with the Eskom emergency measures, which is really a 30-day ahead focus on what is required. There is a large requirement for co-generation so the speed of market reform has actually been speeded up by the War Room because when we run out of capacity we have days in South Africa where we have to implement load shedding. The government doesn't like that. It's not good for the economy. It's not good for the voters and so they're saying that anyone who's out there that has some form of generation is welcome to come to the table. An inability to keep the lights on is speeding up the market reform in South Africa. I mentioned gas but a specific focus at this stage is on gas imports from Southern Africa, mainly Mozambique and Botswana and Namibia. Coal and independent power producers are also being asked to step forward. Many people claim they can produce a power from coal cheaper than we can. They are being invited to tender and also then the demand side arrangement and approaches on energy efficiency. That's a very brief introduction to the War Room. It was established on the 10th of December and it has various goals that you can see down on the lower parts of the slide. It's something that we did not have 2 months ago...3 months ago. We do now have it in place.

If you move slide it summarizes what is happening and what we are feeling as a utility. It's the immediate measures to improve maintenance and operational practices—power gen and gas. Independent Power Producers, on the previous slide, I mentioned are called IPPs but it does not preclude or exclude wind and solar and other independent power producers.

On the next slide you can see how seriously government is taking the War Room structures. It goes right up to a cabinet level and is actually run by the Deputy President who makes appearances on a regular basis. The real work is done in the Technical War Room, the light blue block in the middle there, and basically it's about getting the decision makers in the room to make the necessary decisions that need to be made. So far it's been reasonably successful. I think there's a huge opportunity for 21CPP involvement in here and Doug has been trying to get in and I'm trying to get them in as well. As well as other people that might be on the line, we feel that they would be able to help. The government is very open to help at this stage, as long as it's constructive and for the good of the country.

The next slide is also quite a busy slide and it could take an hour or two to discuss. You'll be pleased to know I've only got three more slides. This is just to indicate probably the most burning issue in the country at the moment, which is the inability to meet demand. I'll take you through the colors very quickly but you might have to go and spend some time on this slide on your own. On the left hand side on the x or...so...on the y-axis we have the megawatts that are either capacity or demand, but it's on megawatt scale. The x-axis is time going forward. The dark black line is the demand forecast in the country in that period. You can see that there are various scenarios for demand forecast going forward, depending on demand side management and other suppliers entering the market. The dark black line would be what Eskom expected to meet. The blue at the bottom is the ability of our coal fleet to generate. If we only had the coal fleet with would not meet the black line, so we would have load shedding and additional shortage of capacity. The white is gas. We do have gas turbines, which are supposed to be used for peaking, but at this stage we are pretty much running them at mid-merit. That's costing us an absolute fortune, close to \$1 billion USD per year to run those gas turbines just to try to get closer to that black line. The green area is what we would like to take out and what we are currently taking out on planned maintenance. The yellow area at the top will...or the orange area at the top is what is unplanned or breakdown maintenance. That's really the issue for us because everything that's in the yellow area at the top is not available for the blue area at the bottom. We've got to try and push that blue area up and reduce the yellow. At the moment the only fact you have in the system is the green. You do less maintenance in order to keep the lights on but that is a very short term and unsustainable approach. This issue of capacity in the country is proving very very critical and driving all the short-term decisions that are being made. Next slide please and this is my second to last slide.

The next two slides are really just for information of the attendees. The one is that an RFI was recently issued by the South African government for interested parties for the purpose of expressing interest in participating in the development of strategies for demand response or distributive generation. So Doug, this is an interesting one in terms of the workshop we will be having next week. The government is looking for distributive generation options, which in many cases involves distributive renewables. They put out that RFI in December and it close in January and they got over 100 responses to that in various sectors of the economy saying that we have the ability to provide some solutions to South Africa. The next slide, which I'm sure I know that NREL is very aware of, is the small scale renewable integration, which has been on the backburner for many many years, has finally started to move. NEROSA, which is our national energy regulator has put out a white paper, we call it, in South Africa, or paper for comment, which is really the small-scale embedded generation regulatory rules. It was published last month is now out for public comment. That will hopefully open a way for small-scale i.e. roof top and distributive generation in South Africa.

So that's the end of my slides. Sean, I'll hand it back to you now. The last slide is really just my details. People are welcome to contact me. I'm sorry if I had too many slides and I ran over your time.

Sean

Great, thank you very much Barry. Now we will move on to our last speaker for today, Efrain Villanueva.

Efrain

Well, thank you very much. Good morning to you all and good afternoon in South Africa. I am very pleased to have this opportunity to participate in this webinar over systems of the future. I want to thank the organizers and the 21st Century Power Partnership to have this opportunity.

The next slide I just want to present the main questions that we are having right now in Mexico and to have this opportunity to reform the energy sector in Mexico. Why an energy reform? What's so urgent in Mexico? Well, I believe that the actual prices of oil, that is an answer to the effort that we have been doing in Mexico to make some important changes in the electricity and energy sectors in Mexico after more than 7 decades for the oil industry and over 5 decades for the electric power sector. Mexico's energy sector legal and regulatory framework was strengthened so that it can face the challenges that a transition toward a more sustainable energy system will impose and be needed at this time. In this regard, we are moving from monopolistic views strongly dominated by the two state owned companies, annex in the oil industry, and TFE the federal electricity federal commission in the electric power sector with limited private investment opportunities. We have been changing to a new structure where public and private investments complement each other to achieve the national goals. The next slide please.

I just want to briefly comment what we have been doing in these reforms that began in the last December 20 of 2013 with the Constitutional Amendment supported by the main political forces at the National Congress. Right now we already published a list under discussion, the initial draft of the Clean Energy Quota that establishes 8.2% of total electricity use. So, you can see that the coordination between the legislators and the executive branch produce most of the legal framework in Mexico that provides 21 laws. Among them, two new laws are directly connected with renewable energies—the electricity law and the geothermal energy law that I will comment on in a minute. The whole regulations, guidelines, and the most necessary documents, as for instance the transition strategy, to promote the use of cleaner fuels and technologies. All of them are already published and all of them have the objective to enhance the opportunities to the energy efficiency and renewable energies offers to sustainable development. The next slide please.

As I mentioned we are, right now, discussing the Market Guidelines for Mexico's wholesale electricity market and so we have discussed also the clean energy quota that each one of the most important methods to the stakeholders in Mexico. The next slide. The next please.

In this slide, that is included in the Power Systems of the Futures document, Mr. Doug Arent just commented right now, we have two kinds of scenarios.

The pre-reform, when you can see the dominate role of the CFE, the Electricity Federal Commission, in Mexico, that controls most of the important areas in generation, in control dispatch, transmission distribution, and even the marketing. In the new scenario in reform, the planning stages as well as transmission and distribution segments are still under state control, but the new legal and regulatory framework allows for public/private partnerships for the reinforcement and expansion of grid infrastructure. That is a most important issue in Mexico because we really are concerned about the state of this infrastructure. We need to approve it and we believe that with this kind of partnerships and without the private capital we can't allow this. On the other hand, CFE is transforming into a state productive enterprise with technical management and budgetary autonomy, besides the establishment of an independent system operator that is Cenace—the Control of Energy National Center. Also, the Energy Regulatory Commission, CRE, is strengthened by granting legal personalities, technical, and management autonomy, as well as budgetary self-sufficiency. For instance, also, the Energy Secretary, SENER, is also strengthened as head of the energy sector, especially in coordination and planning of activities. It is really a huge change in Mexico that this new institutional role for Cenace for CFE for CRE and even for the National Secretary of Energy. The new roles for generation are right now under the coordination of Cenace, the operation of short and long-term markets. The control dispatch will be also under the control of Cenace. The initial market rules are already published and it is up for discussion for the comments and opinions for stakeholders. Also, the new role of CRE at their regulated targets is supervision of interconnection is underway. It is quite important, this new scenario in Mexico because the market, wholesale market, is also underway and the minimum consumption to be qualified users is established and also the other requirements and final rates for basic service will be discussed and established in Mexico. The next slide please.

This is the...what we are trying to obtain in terms of the clean energy goals in Mexico. In the left side of the slide we can see the initial year, 2012, where the renewable share is just about 14.8%. Last year, the first semester of last year, the generation of renewables reached 21.3% and the goal established in the special program for enhancing renewables in Mexico set for 2018 we need to reach 24.9%. There are legally binding targets for fossil fuel based power generation. I stated that the loan for renewable energy utilization and financing of energy transition, fossil fuel based generation must not exceed a share of 65% in 2024 and 60% in 2035. As of 2012, renewable generation, as I already mentioned, accounted for 14.48%. The increase in the first semester of last year is a huge amount, 21.3%. There is a national renewable generation target for 2018, which was set by the special program for enhancing renewable energies. That is a kind of law right now in Mexico. The next slide please.

One of the important mechanisms for supporting the clean energies is right now the Clean Energy Certificate that was established in the electricity industrial law. Clean energy certificates would provide an additional source of income for clean energy generation, thus making renewables and other clean technologies more competitive vis-a-vis conventional generation.

SENER establishes a quota for clean energy participation that right now is at 8.2%, but it is just a under discussion for the opinion and comments for stakeholders. It is important to mention that SENER also published the initial draft of clean energy waters and rules of the market that is on the website of the Federal Commission for Regulatory Improvement in order to receive these comments and opinions for the stakeholders. In this slide you can see how this Clean Energy Certificate will be used as a percentage of clean energy and suppliers will feel the requirements for buy-in certificates and this income from certificates sales allows clean generators to cover their costs. This is a really important mechanism for clean energies in Mexico that never existed before in the former sector in Mexico. The next slide please.

Some of the new mechanisms for improving Clean Energy Certificates, improving clean energy in Mexico, are the Geothermal Energy Law. This new law regulates the stages of surveying, operation, development, and production of geothermal resources according to international best practices. We need to remind that Mexico is the fourth largest producer of geothermal energy worldwide. This new geothermal law also defines and differentiates them from conventional aquifers and permits specialized regulation. CFE will have a geothermal Round Zero. It's a preference for this price given it's 120 days to determine which areas to develop. We are working in this process that will end next July that CFE will have the areas that they will continue exploring or developing in geothermal new areas. The law also established that CFE will have public/private partnerships that perhaps will enhance the possibilities to work with the potentials that Mexico already has with geothermal. Other projects can be tendered by SENER, tying to a law the private sector capital producing new geothermal energy in Mexico. Next slide.

SENER is jointly working with other institutions of the Mexican energy sector with the aim of making accessible information on renewable energy resources to potential investors, thus SENER has published the National Inventory of Renewable Energies using a geographic information system and a local database. Additionally, there are cooperation activities, within the government, improving wind mapping and the development of a wind atlas in order to improve the accuracy of forward generation forecasts. In Mexico we also have a new initiative that is already discussing in the National Congress, to have a new Energy Transition Law. This new law provides the possibility to focus in on very enticing areas for renewable energy.

This national inventory will be connected with this possibility and also with improved administrative procedures...the next slide please...we also have been working on how to reduce the time for getting a permit for private investors. These administrative procedures for licensing, permit and interconnection applications will be also improved, reducing considerably the steps and providing more transference to the evaluation processes for potential projects. In this regard, SENER is celebrating the web-based platform intended to manage all administrative procedures associated to the construction of renewable energy projects. We expect to reduce, as much as 35%, the number of days required for the whole procedures. The next slide.

Another possibility in Mexico is about distributive generation and smart grids. Before reform, generation in small installations could not sell surplus. A credit was awarded also toward consumption, but avoided rates were often lower than market values. In the new context, after the reform, regulated suppliers will pay a regulated price for surplus energy and unregulated suppliers can buy from all users at market prices and minimal regulation of on-site sales.

Distributed generation will also have a better environment for renewables. Final consumers will now get a fair payment for the electricity they fed into the grid, not only credited towards users of electricity consumption, as in the former regulatory framework. SENER and CRE are also working on the implementation of a smart-grid roadmap intended to facilitate the integration of distributed generation in Mexico. The next slide.

Well, it is important to mention that many activities are going in the frame of the 21st Century Power Partnership. As I have shown in the previous slides, we have started a process of transformation of the electric power system in Mexico, but we are aware it will require not only time but also the available experiences worldwide. In this context we work very closely with the US National Renewable Energy Laboratory in order to bring to Mexico best practices available, while customizing them to the local environment. In this sense, this slide summarizes the status of current and foreseen activities in the frame of the 21st Century Power Partnership. Renewable Electricity Grid Integration Road Map for Mexico is completed right now. The report on Regulatory Mechanisms for Enhancing the Adoption of Distributed Generation, well, this is in the process of collaboration also with the CRE. Our workshop on the implementation of the Smart Grid Road Map was last February and with the National Renewable Energy Laboratory and the National University of Mexico we have a training course on the grid integration for photovoltaic generation that is doing right now in the CENACE with participation of people from CFE and CRE and even from the main CENACE. Electric Power Systems Transformation Road Map for Baja California Sur is in process. This is an important issue because Baja California Sur is a kind of island. It's not connected with the national grid and we are trying to find how to solve the problem that this faces now in Baja California Sur. The implementation of market monitoring is in process of elaboration so another policy for smart-grids and also for further planning issues is the whole set of this energy reform in Mexico. I believe that at this moment the energy reform in Mexico, where they have the participation and the support in terms of the context of the 21st Century Power Partnership, it is really important that understates what we have in Mexico. Thank you Sean.

Sean

Thank Efrain and also thank you Barry and Dr. Arent for the presentations. At this point we'll move on to the question and answer session. So, just a reminder to all our attendees if you have any questions for the panelists you can submit those through the question pane in the GoToWebinar window.

The first question we have is directed toward everyone. Maybe we'll start with Doug for this one. It asks—could you please describe some of the activities that 21CPP is involved with across the various countries?

Douglas

Well, thank you Sean. Efrain did a very excellent job on his last couple of slides describing some of the activities we in Mexico and related to the Mexican work. I should mention as well that those are very much done in partnership with the Danish and German colleagues as well as in a multilateral context with colleagues from South Africa, India, as well as our European colleagues as well. In addition, Barry mentioned very briefly that next week there's a workshop on distributed PV regulation hosted in South Africa, hosted by organizations there in partnership with the 21st Century Power Partnership, where colleagues from around the world will gather to discuss best practices in distributed PV regulatory approaches. Another activity that we also have been involved in is a Renewable Energy Roadmap in India working with colleagues and counterparts there, as well as with Danish and German colleagues. Those are examples of specific activities in addition to the thought leadership reports, of course, and supporting webinars like this. Sean back to you.

Sean Great, thank you Doug. Next question is for Barry and it's in regard to South Africa. You mentioned some of the electricity issues and challenges and this attendee is just wondering if the nuclear power plants in South Africa have helped address any of those electricity issues?

Barry

Interesting question. I've only got one plant at the moment, which has got two units. We've only got 1,800 megawatts of nuclear on board but I think for sure it has helped addressed some of the difficulties of keeping the lights on because, by its very nature, nuclear is a very reliable source. When I indicated one of the problems is the unreliability of our existing plant, I'm pleased to report that our nuclear station has been very reliable. From that perspective it's been tremendous in providing enough capacity for the country. Also, if you notice South African geography, the nuclear station is down in the south in Cape Town, which is right at the bottom of the country. That is situated great with the power flow issue that we have from north to south and vice versa in the country. If you lose the nuclear station, we have a transmission problem and a voltage slide issue in the country. Yeah, we're very pleased to have that station and I know nuclear is a big debate worldwide but if it's done right and it's run properly I think it's a great technology and we look forward to having more of it on our system.

Sean

Great, thank you Barry and next question is for Efrain in particular to Mexico. It asks—renewable energy in 2012 was 12.8%. Do you know about what that equates to in megawatts and also, second part of the question, what type of projects or technologies were added to take that number up to 21% plus in 2014?

Efrain

Well, mainly the most important technology that is coming in Mexico is wind power. Wind power produces from 2012 to last year an amount of one gigawatt additional. It is a really huge amount from wind and also we believe that with the new geothermal law we will also have a huge more potential for

geothermal energy. It is really important that just a few weeks from now the Wind Association in Mexico announces investments for at least \$40 billion USD in Mexico. That means for the end of this federal administration in 2018 they will provide also about six gigawatts additional. It is really an important announcement in wind but also in solar, in Mexico, they are also trying to provide more generation from solar PV and we are just trying to obtain experiences from CFE. For example, I saw that South Africa is really committed with this kind of technology but in Mexico the most important technology right now is coming in wind power.

Sean

Thank you Efrain. Another question that just came in notices that the focus seems to be more on the generation side. What percentage of projected demand is expected to be met through demand side management and/or energy efficiency? I think I heard Barry jumping in there?

Barry

You heard Barry sighing. In my one graph I've got the one that shows all the different colors and shows the demand as a thick black line and it's got all the other colors on, there is a drop in demand based on demand-side management that is full cost for that period. It's not a small amount. I'm just trying to look at that graph now. It's about 1.5 gigawatts of demand side kicking in almost immediately and growing to 1.5 gigawatts of demand-side management demand reduction in about a year and a half to two years' time. If the panelist is interested they are welcome to contact me. Eskom has got a very good, in my opinion, demand-side management focus and there's a lot of work, everything from low energy light bulbs to solar water heaters to customer incentives, etc. It's almost, at this stage, as big as wind but wind and solar will overtake it.

Sean

Thank you Barry and Efrain, did you have something to add as well?

Efrain

Well, I just want to add that we really are interested in coal too. We are working with CENACE in trying to obtain more building capacity in this national control center for electricity because we expect, as I already mentioned, a huge amount of intermittent generation, mainly solar and wind, and we are working close with CENACE to have this new efforts and new possibility to administer more generation from intermittent energies. So, with the support from NREL, from the support from other national corporations, trying to find the best practices worldwide, we believe that we will improve the possibility to handle more generation for this kind of technologies.

Douglas

Sean, this is Doug, if I may just jump in here just very quickly? As I mentioned, the partnership really takes into account the efficiency side of the equation as well as demand-side management or, more broadly, demand response. I think one of the important things for the audience to understand is that the comprehensive aspects of thinking about policy and regulatory reform for the power sector are just not about peak load management but they are about system optimization and enabling that kind of demand response and demand-side management activity and value, doing it appropriately, are core elements of a holistic design transformation going forward. They are central in many of those pathways, as we've articulated in this thought leadership report.

Sean Great, thank you everyone. The next question that we have asks—we hear a lot about feed-in tariffs, energy efficiency, and smart-grid programs and how should we think about these in relation to what you presented today? This is a little bit related to the question that you just addressed as well.

Douglas I'm happy to jump in here and Efrain and Barry please do so as well. I think importantly feed-in tariffs and programs as they've been designed and thought about over the last many years, are really support mechanisms. As Efrain, I think, described some elements of the Mexican energy reform, they are a bit of I'll call it "the how" in terms of activities in terms of activities to implement towards certain goals. Those goals, really "the what", are defined in terms of IRPs—Integrated Resource Plans—or the quotas that were described previously as examples, but the feed-in tariffs and the efficiency in demand response are tactical elements of "the how". They are also complemented, as you can see in going forward, with structural reforms, which are the more critical, if I can use that phraseology, elements of power sector transformation going forward, which includes the evolution and the creation of regulators, market operators, enabling independent power producers, or distributed generation service providers. It's part of a larger package as we see this transformation going forward but Barry, Efrain, if you would like to comment that would be welcome as well?

Barry Yeah, thanks Doug.

Efrain In the case of Mexico, it is important to promote support mechanisms for clean energies but at minimum costs, that's for finance options. That's of the main topics that we already have in Mexico. With the Clean Energy Certificates that are under design in Mexico we believe that we can find and provide the necessary support to increase the clean energies in Mexico. We believe that the market rules in Mexico, this is also a new issue in Mexico, will provide certainty that are most important to stakeholders in Mexico that are interested in participating in the new energy reform in Mexico, the new scenario in Mexico. We understand that feed-in tariffs established in other countries and that provide an important decent of the cost of the technologies we, in the state of Mexico, are trying to obtain the best practices worldwide but also establish the own pathway in Mexico just trying to understand what happened in Germany, what happened in other countries for instance. We need to establish the Mexican pathway in this sense. We understand that the Clean Energy Certificate and the guidelines and we hope we understand Clean Energy Certificates and how we finally establish the proportion for Clean Energy Certificates that we start in 2018. That will be the most important issue at this moment in Mexico.

Sean Barry we have about 30 seconds if you have something else that you'd like to add.

Barry No, no, just when it comes to refit feed-in tariffs we think they have their place. They tend to be useful in short-term applications where you've got a particular problem that you're trying to solve, but we would strongly advice that you limit the times you duration and cost impact and rather go for a more sustainable market driven approach but they definitely have their place.

Smart-grids, absolutely, we love them. That's the glue that binds this whole matrix together and I think we should have another web-cost at some stage just on smart-grids. I think it's a topic we'll understand.

Sean

Great, thank you Barry. Thank you to the rest of the panelists once again. We are out of time so we'll wrap things up now.

I would like to ask our audience to take just a quick survey on the webinar that you viewed today. We are displaying the first question now and that is—the webinar content provided me with useful information and insight? The second question is—the webinar's presenters were effective? Then the final question is—overall, the webinar met my expectations? Great, thank you for answering our survey and on behalf of the Clean Energy Solutions Center I would, once again, like to thank each of our expert panelists, and to our attendees, for participating in today's Webinar. We very much appreciate everyone's time and are glad you are able to join us. I do invite the attendees to check the Solutions Center's website if you'd like to view or download the slides. We'll also be posting a recording of today's presentation there within about a week. Additionally, we're now posting webinar recordings to the Clean Energy Solutions Center YouTube channel. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including our no-cost Ask-an-Expert policy support. With that I hope everyone has a great rest of your day and we look forward to seeing you again at future Clean Energy Solutions Center events. This concludes our webinar.