CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Deploying Smart and Strong Power Grids: Best Practices from Austria, Ireland and Around the World

—Transcript of a webinar offered by the Clean Energy Solutions Center on 6 May 2015—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Presenter

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Speaker Welcome you to today's webinar, which is hosted by the Clean Energy Solutions Center, in partnership with the International Smart Grid Action Network. Today's webinar is focused on deploying smart and strong power grids, looking at best practices from Austria, Ireland and around the world.

Now, before we get started, I'd just like to make one disclaimer. 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 practice resources reviewed and selected by technical experts.

And before we begin, I'll quickly go over some of the webinar 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 on the right side of your screen. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option and a box on the right side will display the telephone number and audio pin you can use to dial in.

If anyone is having technical difficulties with the webinar, you may contact the GoToWebinar helpdesk at 888-259-3826 for assistance. If you'd like to ask a question during the webinar, we ask that you use the questions pane where you may type in your question. We'll be collecting these throughout the webinar and we'll make sure they're all addressed at the end of the webinar. If you are having difficulty viewing the materials through the webinar portal, you will find PDF copies of all the presentations at cleanenergysolutions.org/training and you may follow along as our speakers present. Also, an audio recording of the presentations will be posted to the solutions center training page within a few weeks and will be added to the solutions center YouTube channel where you'll also find other informative webinars, video interviews with thought leaders and other clean energy policy topics.

So agenda for today's webinar, it's centered around presentations from our three guest panelists, Bo Normark, Helfried Brunner and Seamus Power. These panelists have been kind enough to join us to highlight cases primarily from Ireland and Austria. Ireland has improved the security of its supply and its network by providing additional capacity. The goal of the Austrian project is to find an efficient way to integrate renewable base distributed generation with optimal investment and maximum utilization of the existing asset base. _______ from other cases like the United States' work with wide area reliability will also be shared.

And before our speakers begin their presentations, I'll provide a short, informative overview of the Clean Energy Solutions Center initiative. Then, following the presentations, we'll have a question and answer session where the panelists will address questions submitted by the audience. We'll have some closing remarks and finish with a brief survey. So this slide provides a bit of background in terms of how the solutions center came to be. The solutions center is one of the 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011 and is primarily led by Australia, United States and other Clean Energy Ministerial 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 this webinar today. The solutions center has four primary goals. It serves as a clearinghouse of clean energy policy resources. It serves to share policy best practices, data and analysis tools specific to clean energy policies and programs, it delivers dynamic services that enable expert assistance, learning and peer-to-peer sharing of experiences, and lastly, the center fosters dialogue on emerging policy issues and innovation around the globe. Our primary audience is energy policymakers and analysts from governments and technical organizations in all countries, but we also try to engage with the private sector, NGOs and civil society.

One of the marquee features of the solutions center 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 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 J. Riley Allen, research director for the Regulatory Assistance

Project, 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 encourage you to use this valuable service. Again, the assistance is provided 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 contact Sean Esterly directly at sean.esterly@nrel.gov, or call 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 of today's panelists. Our first speaker today is Bo Normark. Bo is the chair of ISGAN Annex 6 and is co-chair of the Energy Platform of the European Council of Academies of Applied Sciences, Technologies and Engineering. He is also vice chair of the National Council for Smart Grids in Sweden and board member of the Swedish National Grid Company, the Swedish Transmission System Operator.

Following Bo, we will hearing from Helfried Brunner. Helfried is currently thematic coordinator for power system planning and operations and responsible for related projects on the topic. Helfried is also an Austrian Institute of Technology representative within the European Energy Research Alliance Joint Program on Smart Grids and Technical Coordinator of the Integrated Research Program ELECTRA.

And our final speaker today will be Seamus Power. Seamus works as a senior engineer in the Sustainable Power Systems team of the operations department in EirGrid, the Irish TSO. As part of his work on the DS3 Programme, he conducts technical analysis and develops control center operational policies for power system operation with very high penetrations of wind power.

And with those three introductions, I'd like to go ahead and welcome our first speaker, Bo, to the webinar. And Bo, if you want to go ahead and unmic yourself when you're ready.

Bo Normark

So thank you _______. I'm happy to be on this webinar and I serve as the chairman of ISGAN ________ power fueling systems and today we will introduce some material that has been collected in a casebook called Spotlight on Smart and Strong Power and T&D Infrastructure. First of all, I've been – ISGAN is one part of the Clean Energy Ministerial Initiative that started as a result of the ______ in Copenhagen, where it was felt that ______ ____ to find new ways to share experience and best practice. ISGAN is, in fact, as you can see, 1 of 13 initiatives and we are talking in the box that talks about integration, because grids is actually about integration of different services of production and of course ______.

I think that the smart grid, the concept has gotten increasing interest not the least if you look to the increased penetration of wind power, and you will hear some good examples of this later in this webinar. First, on some few words about what we try to accomplish in ISGAN. I mean, ISGAN is not different from other initiatives, but I think I would still like to highlight that we do believe that we can have a broad expert network, we have through the pipe 50 percent of the _______ and with that, we can find examples of many different solutions that are ________ particularly in other countries.

We also believe in partnerships through _______ thought leaders, we have a lot of experienced people that can share their views, and one of the ways to share them is using the webinars like this you also see that you have – sorry [inaudible mumbling]. I would say also that we have very diverse portfolio, and we try to use, as far as possible, the experiences gained in many countries and we try to see where there are good people in other areas.

Also we mentioned the focus, we have 25 contracting parties in ISGAN, and as you can see on the map, it's a quite broad geographic spread, although we of course today needs South America, that we hope can join later. Sharing knowledge, we have already within ISGAN actually you see the number of documents. Additional international casebook on advanced metering infrastructure, demand side management and there is also an online database that shows the smart grid activities in many of the countries.

Today we would focus on the recently issued casebook applied on smart and strong power T&D infrastructure. We had in collecting these examples, we have looked at the key drivers for implementing smart grid solutions, and the key drivers are in integration of renewables, improved markets, engage customers and to increase security of supply.

If you go the list of all the examples that you find in the casebook, they cover Ireland, Sweden, United States, Italy, South Africa, France, Austria and Italy. You can see that they are addressing around two or three of these main drivers for building smart grid solutions.

We can also see that we have examples both of TSO level and on DSO level and one example is actually in the borderline between TSO and DSO. And we will describe all these, some of them briefly, and we will dive deeper into Ireland and Austria.

So first highlights, because in all the – if you go through the casebook with ______ _____ ______ highlight. The South-West Interconnector in Sweden is an interesting project that shows a combination of AC and DC technologies and a substantial amount of underground DC. The idea with the product was to take the benefits of the AC and DC technologies and combine it in one common transmission system. One thought – the part is a 200-kilometer, 1200-megawatt underground line and that underground was used for the purpose of avoiding to open new right of ways and by that, having a faster _______ for the project. The project also demonstrates the ancillary services, in terms of voltage collapse, we have also a lot of stability feature, since the basic _______ is not to source _________ technology that offers a lot of possibility.

Next example is from France, where you will see actually description of smart substation. And a smart substation is implemented both for reducing environmental impact, again, for integration of renewable energy, increase transmission capacity and optimize the use of existing assets. That's something that I think you will see in many of the smart grid solutions that it's extremely important today that we use existing assets, since in the grid, we want to not only add capacity but we also want to find ways to better utilize existing assets we can for ______ _____.

The France example shows a fully digitized system, also it's using an open architecture with IEC 61850, which is quite important since this architecture allows to have multiple members in the structure at a later stage. There is also implementation of a lot of new sensor technologies. That's another key thing you'll find in many of your smart grid applications, that sense will give input to do more intelligent positions.

South Africa has an interesting example with grid situation awareness. It's actually a visualization system that helps the operator to take better decision and take a better decision both in terms of scheduling maintenance and preventative maintenance and ______ faultfinding. The system has shown to give reduced downtime and also give early warnings to the operator so they could take action before a situation goes from being critical to be actually a disaster.

Next example is in Italy, and this is – shows the depth of what we are looking at. This is an interesting case that was done to look at customer response under time-dependent electricity prices. The project was quite comprehensive, the end customer got access to time-dependent pricing and they could adjust their behavior. One interesting thing that was found in this was actually that it's – the customers will need stronger price to get more response with that. It increased the responder benefit, result is also of course that at least ______ for a significant price _____ ______ would have a major ______ on customer behavior.

But also the other it shows that it is possible to increase the efficiency within the system, and it was good for really state the customer role. You have also in Italy WAMS project, wide area measurement system that has been implemented. And there it was – has been proven that wide area monitoring is cleaner way to be able to use – the safe way to use existing _______ that's at a higher capacity. We can talk more about WAMS experience in the United States.

So now we go to United States. In the United States on the west coast, Bonneville Power Administration, which is a major utility on the west coast, actually got involved in a synchrophasor project that was funded by the Department of Energy's Smart Grid Investment Grant Program. And they have invested, as you can see on the map, not less than 126 phasor measurement units, with the substations and also through the _______ ______ wind generation, and all these sensors gave input to this synchrophasor project.

And so to be able to take the right decision, we must start with collecting the right data. And today, BPA _____ to have the most sophisticated synchrophasor of any utility in North America. What was also developed in the process was a very comprehensive data collection system, and you'll see also there that actions need to get taken in less than one second. And the system had proved itself to be able to _______ in performance and again to ensure a safe operation of the system.

And in brief, this is the financial results. We see firstly there that BPA is expecting to defer the need for 40 million in dynamic voltage control over the next 10 years. That's, of course, important. But the second goal is probably even more important. Because what we really are afraid about in the power grid is unlikely events that have I will say catastrophic impact. And the catastrophic impact is blackout, and based on historic data, it's estimated that BPA, with their grid, could avoid at least one large-scale outage in 40 years. And one outage in itself can create a damage of between one and two and two and a half billion. So this really shows the span. I need to say that this whole _______ is probably like a technical insurance against blackouts.

The system also complies with all the global standing – standards and that _____ _____ ______. So it's a combination of saving investments, saving money or comply with standards, but not the least organization will have ways of stopping failures. So with that, I would like to hear the word to Helfried and Seamus and they can give you an insight of the more detailed examples to our panelist.

Host — Thank you very much, Bo, appreciate it. If anybody has questions for Bo, please go ahead and ask them through that questions pane on the right side of your screen, and we'll address them at the end of the webinar. And in the meantime, we'll move on to our next panelist, Helfried Brunner.

Helfried Brunner — So hello, thank you for having the opportunity to present the Austrian case on integration of DER and maximizing the hosting capacity of low voltage and medium voltage networks.

So as I would imagine, many of us are familiar then with the Austrian Institute of Technology, and just a brief introduction into Austrian Institute of Technology. So we are the largest non-university research institution owned half by the government, Austrian government, and half by the Austrian industry, and that's actually our role in the Austrian innovation system is to guide the industry towards developing in key infrastructure topics like electricity networks. So our focusing is on applied research, and for that reason, we are involved in a lot of pilot projects dealing with the integration of renewables and electricity grids.

I'm going to present some – in the beginning some facts and figures about Austria and the Austrian power system to understand also why we do some things, then I will focus on the objectives and activities that relate to technologies we've developed and tested within the pilot projects, and some slides on the results and also the next steps and will conclude with a short summary.

So the Austrian power system, so the structure, what we have is Austrian – Austria is located in the heart of Europe and we are a rather small country with eight million inhabitants. Nevertheless, we have one TSO covering the entire transmission system, and – since we aren't a huge country, we have 130

DSOs, so that's also for historic reasons. So there's really a high number of DSOs, mainly public owned, in Austria. And so and we've – therefore we have the focus also in our research in distribution system operators so far.

We have a fully deregulated retail market and electricity consumption of around 70 gigawatt hours a year, peak demand 10-megawatt hours and installed power, that's gigawatt hours, and installed power, 23 gigawatt hours. And that's mainly caused by the high availability of hydropower we have in Austria. So we are located in the – also in the heart of the Alps, so what we have a lot of hydropower and ______ plants as well as pump storage power plants.

So around 60 percent of our annual electricity in Austria is produced by hydropower plants and the rest by thermal and wind and other renewables like photovoltaics. So highly – also highly renewable, and the _______ you will see this is then itself. So as you can see, we have several voltage levels, 300 kV to 120, which is considered as transmission system, and 110 and below as distribution system. And just to pay some attention on the cabling degree we have, so particularly in the distribution system, we have really a high share of cable systems and also in the last 10, 20 years, it's further increased, and at the same time, the share of overhead lines was reduced.

As I already mentioned, we have in the distribution system mainly three voltage levels. Just to give you some understanding, 110 kV, and then medium voltage level is 10 kV mainly in urban areas, but cannot be found that often anymore, and mainly we have 20 kV and 30 kV through the phase medium voltage system. And from the medium voltage system, well, secondary substations will supply low voltage networks, and that's also somehow different to many other countries all over the world and quite common in Europe. We have three phase of four-wire, three-phase system including neutral wire in the low voltage levels. So with geographic dispersion of around 50 or several hundred meters. So it's really also can be considered as networks, so between a couple of households and several dozens of households are connected to a low voltage network.

And that's – I think it's very important to consider that when I speak later on about the low voltage system project. As already mentioned by Tim, so one of our main drivers for the Austrian Demo Case and the related projects is the massive introduction of additional renewable base distributes generation and here we are speaking mainly about wind, biomass, small hydropower and of course, also photovoltaics.

And for that reason, the objective of our projects was how to integrate all this distributed generation into the existing asset base. So the focus was to maximize for that reason the hosting capacity of the existing medium and low voltage networks, and one of the main challenges concerned that in particular also in rural networks is keeping the voltage within the – [Break in Audio] low and medium voltage systems in order to make it possible to actively integrate distributed energy resources in the network, giving them an active role in the system. So quite – to integrate them, instead of, of course, the former and probably also current status of fit and forget. So once a distribution generator is connected to the network, it has no active role in the system.

The Austrian are including several individual projects, so we have two main – so there's the branches. The one is the hosting capacity of medium voltage networks and the other one is hosting capacity of low voltage networks. And we had, in the medium voltage, two specific field test areas in Austria, here you can see on the slides the name, in Großes Walsertal and Lungau. So we went with our controls and new approaches into real networks, strongly supported by the related network operators, _______ ______ _____ _________ it was very, very important to include from the very beginning also the network operators.

And the same was true for the low voltage concepts presented, also in the casebook where almost the same network operators have been included, and we have really set up also on a very residential level in low voltage networks to field test and to demonstrate the three – sorry, three field tests and demonstrations in Köstendorf, Eberstalzell and Prendt, which are quite usual villages we can find in Austria.

What is actually the impact we finally achieved and also they addressed, of course, in the beginning. First it is the renewable energy sources integration, related also to greenhouse gas emissions reduction. So that's not just an Austrian objective and expected impact, that’s also very strongly the focus of European electricity and energy policies, so to really reduce the greenhouse gas emissions, also in the electricity sector. The related controls and approaches will lead, and finally also led to loss reduction in electricity system and we also tried to integrate the active contribution of producers, consumers and of course, those people who are both the prosumers in electricity can release units as well as electricity levels.

Within the project, and in particular in the low voltage networks, we also tried to make use of synergies with smart metering system, and in particular using the communication infrastructure introduced with the smart meter rollout, which is actually ongoing in Austria. So finally doubling use of existing infrastructure.

And to further deploy related services for grids and also in huge ______ markets. So that's what we are aiming in and what's finally also the impact of the related projects.

Coming to the technologies, so in medium voltage networks, so just to remind you we're talk about three-phase, 20 dive networks, we introduced 2 different approaches to maximizing the hosting capacity of medium voltage networks by active voltage band management, as we called it, and the main measure for voltage band management, sorry, was two on two levels. It's basically to control the substation from 110 to 1320 kV, to tech change with information and measurements or even a state estimation from the network. So not just consider the voltage on the _______ at the substation, but also consider measurements from the network.

And that's basically the same for the two approaches we developed, but the one is really integrated, because it's – the related project is called ______ ______ approach, so we have a standalone solution integrated at substation level, based on measurements from the grid and depending on the voltage situation in the system, the ______ tech changer is controlled, and additionally selected distribution generation units are involved in the voltage control via reactive power management. So the controller sends, if we pressed it, also reactive power send points to the individual – to the distribution – distribute the generators in order to keep also the voltage at all nodes in – within the specific limits.

What we also consider, of course, is some of the contribution in that direction of the individual distributed generators to the voltage – actual voltage management via reactive power control, and therefore we introduce then what's called contribution metrics. So really having the dependency of reactive power flows and the voltage.

Basically the same overall approach and objective is a solution, that's the second one, it's an Austrian acronym, ZUQDE, it's – basically it's a distribution management system with a model integrating a state estimation based volt bar control. So the difference between the two is the one is a standalone, you don't need a process control and ______ system, and the second one is integrated in a distribution management system and based in the control center.

And by these two approaches, we've been able to really significantly increase the hosting capacity of the existing networks, just to give you some numbers. So in the two network areas, we had an increase between 50 and 60 percent of possible DG to be integrated, so that's quite reasonable. And also we did some cost-benefit analysis and depending on the network, it was a cost reduction compared to necessary grid reinforcements if they want to integrate the same amount of distributed generation. So the reduction was between 5 and 85 percent, and so you can see it very much depends on the actual situation in the grid where you are going to integrate. But anyway, it was quite promising, and I will focus on the next step and what's going actually on at the moment in one of the next slides.

And as you can see, it was a real pilot operation, here are the colleagues from Vorarlberg, from the western part of Austria where we started this pilot operation and receiving measurements from the grid, the status if the individual distribution – distributed generators, their reactive power flows and how it changed the voltage level. And luckily, after one and a half year of operation, we don't have any big difficulties and it was really, so to say, an operation on the open heart, because it was the real network. It was not just research, so we really run the controls for one and a half year with the colleagues from Vorarlberg Energienetze as well as Salzburg Energienetze quite successfully.

The same with the low voltage network, and here again, please take into consideration we have a four-wire system in Austria on low voltage systems. Most of the – almost all of the households and consumers in Austria on low voltage levels are supplied via three phases, so that's quite different to many other countries. And what we introduced in the low voltage networks is OLTCs on a secondary substation level, so supplying the low voltage area, and then the first controllers that we – it's somehow similar to the medium voltage networks, we controlled the OLTC based on the local measurement as well as the integrated controls in the previous areas and in the low voltage, we had as flexibility with OLTC.

We had the PV inverters with reactive power management functionalities, and in one of the field test areas, we also had charging stations where we were able to influence the charging behavior of the station according to the grid. And then the first step, it was all just based on local controls, so no communication required. And the second step was also receiving measurements from selected points. The measurements have be collected by our smart meters, so as smart meter was not just used for billing, it was also used for network monitoring. And based on the measurements from the grid, we changed the tech position in order to keep the voltage within the limits. And the next step of the approach is if we don't succeed with the distributed control and the OLTC alone, we included the PV inverters, electric vehicular charging stations into a coordinated control also sending out SAT points for reactive power management to the inverters and charging stations.

And in the approach how to develop it, this was very interesting in the low voltage networks was that we first set up real demonstrators. So we included in the three villages, in those villages on every second house rooftop PV installations, luckily with a local funding scheme, as well as in Salzburg, in Köstendorf additional in every second house there was an e-vehicle available. So in parallel, when we introduced, so to say, the future program into the specific network areas in a simulation environment, we developed the related controls I had briefly introduced in the last slide. And as you can see in this, real villages, that's some photos of the three villages. You can see two of them are just usual, common, Austrian villages in more rural environment, and one of them is the Prendt one, it's really very rural, very local including also farming areas, so really to see what is the influence there. And as you can imagine, in particular in rural network areas, the networks are weaker since we have reduced short circuit power there, due to the higher lane lengths, of course.

The results, in particular the medium voltage network, it was very promising finally. So the total system was able to increase the hosting capacity and contribute in a significant amount to voltage band management, as already mentioned, around 50 or 60 percent additional distributed generation can be integrated in systems – in existing systems considering the control functionalities. It was also possible to reduce the losses.

Some of the same is true for the control functions developed in DG DemoNet, so the local one not integrated in a distributed management system, is has been also shown for both cases that it's economically feasible, so compared to network reinforcement, and also in both network areas, the controllers are still in operation, even if the research projects and the field tests are already over, and I think that’s also a nice result for research projects when the controllers are still in operation after finalizing the project.

In the low voltage networks, it was somehow also for all of us and also the involved DSOs a huge surprise that just by ________ what's going on in the low voltage system and monitoring, so having more details, we have seen that there is a lot of we call it expanded reserves in terms of hosting capacity network. Of course, if you don’t have any monitoring, no detailed planning, you need to work with worst case assumptions, and if you really go away from that approach, having more details also some probabilistic net planning approach, just based on worst case, it's really possible to increase the hosting capacity. And of course, also the low voltage control approaches have been very promising, but to quite speak open here, that was also somehow disappointing for the involved technology providers. It's not that necessary the high amount to really include very fancy controls, since also smart planning and monitoring can even enhance and increase the hosting capacity. All smart grid applications have been successfully tested, so we have no major problems and are seeing the future as an overall smart grid approach with additional advanced services, and so that are the next steps, so to start with the second bullet point is what we are currently doing also with the European funded project is to investigate the replicability and the scalability of the developed solutions, because of course, we covered two, three field test areas in medium voltage networks, three in low voltage networks, and now it's up to us to really show the scalability and replicability, and also enable future decision support systems to really give the distribution operator the – an idea when in his network what problem is going to occur and in terms of control functions and solutions, what is the best answer, that’s where we want to go together with our partners from network operators and technology providers.

We're also starting to set up first projects about the interaction of the low voltage, medium voltage network controls. So far, we just considered the individual network levels, and now we also try to find out in line with the goals also and the projects in _______ how these controls interact with the higher voltage level and the transmission system and what services can be provided.

Almost all controls so far are in direction towards commercialization, so these volt _____ control based on state estimation is already – was already introduced in commercialized version from the ______ provider, an _______ in that sense. And these controlling DG DemoNet, we are currently together with an industrial partner, I cannot name him here, we are going to commercialize the function in future project – products and will be available within the next one and a half years. So that also underlines that there have been some promising results.

And last but not least, a summary. Of course, it was possible, as I've already mentioned, to increase the hosting capacity, and I want also to point out even with smart planning and smart monitoring, it's not just true for the low voltage, also it's true for the medium voltage network, you can really enhance the hosting capacity, but of course you need to take into consideration how to manage all these necessary planning work, this monitoring, the data, the analysis, it's also some related work necessary to smoothing that process. Yeah, and the control possibilities have been proven successfully and with the integration and intelligent planning, taking also into consideration some monitoring capabilities, it's really good to improve the hosting capacity.

And as I already mentioned, the next step would really be more on that same line with some other European projects to investigate the interaction of the individual low voltage networks and over traditional boundaries.

So that was my overview about the Austrian demo case in medium and low voltage networks, thank you for your attention.

Host: Okay, thank you very much, Helfried. Appreciate that good presentation. Again, for the audience, any questions that you might have on that or on both prior presentations can be asked through the questions pane on the right side of your screen there, and again, we'll address them at the end of the webinar.

Moving on to our final panelist, Seamus Power, now.

Seamus Power: Yeah, hello everyone. Thank you. Hello everyone, as Tim mentioned, my name is Seamus Power and I work for EirGrid, the transmission system operator in Ireland. So I'm going to present on the East-West HVDC Interconnector.

So the East-West interconnector is a HVDC interconnector that links Ireland and Northern Ireland power system so the GB system and it utilizes voltage source converter technology.

So first of all, just to give you a little context, the island of Ireland is an island on the western periphery of Europe. It forms its own synchronous system and those not synchronically connected to any other system. So just look at a few statistics to give you an idea of the size of the system. So we have a peak demand of roughly 6,500 megawatts and a minimum demand of roughly 2.3 gigawatts.

The installed generation on the island, as you can see there, we have more than enough conventional generation present to meet the load and we have a large quantity of installed wind, which currently meets about 20 percent of our electricity consumption.

Looking at interconnection, so if you include the East-West interconnector that I'm going to talking about, there's currently 750 megawatts of operational interconnection with Great Britain.

A point to note is that Ireland has very ambitious 2020 targets of 40 percent electricity from renewable sources, and the vast majority of that is due to come from wind power. So in 2020, we'll require approximately 4,600 megawatts of installed wind generation to meet the targets, and that means at times, the system will be run with a high proportion of non-synchronous generation, and clearly there'll be times where the available wind generation on the island will exceed the demand and in order to reduce the curtailment, we'll need the ability to export that power from the system.

And finally, if you look at the fuel mix on the island, you'll see that we're heavily dependent on coal and gas, the vast majority of which is imported. And it should be noted that this graph includes the East-West interconnector in operation. So before the East-West interconnector was operational, we had approximately 75 percent of our electrical energy coming from fuel imports.

So even though we have a large conventional generation fleet, fuel security is a potential issue on the island. So what I the East-West interconnector? So it's a 500-megawatt HVDC interconnector linking Ireland and Northern Ireland power system to the Great Britain power system and it utilizes voltage source converter technology.

At the time of commissioning, it was the highest capacity HVDC-VSC interconnector in the world and operates at the highest voltage for such technology, and it can roughly meet about ten percent of Ireland's peak electricity demand.

So the interconnector itself has a cable length of 264 kilometers with roughly 187 kilometers of that subsea, and it links a strong point on the Irish and Northern Ireland network at Woodland to a strong point on the Great Britain network just south of Liverpool.

So from an Irish perspective, it was a huge infrastructure project representing a 570 million investment, and the timelines were very tight. The time from contracts to commercial operation in less than 45 months. So over the course of the project, there were 285 contractors involved, 2.2 million person hours were worked and over 7,300 – or 3,700 people were involved from start to finish.

So just looking at the main drivers and the benefits that are expected from the East-West interconnector. So as I mentioned, the island of Ireland is a small island system and heavily dependent on price volatile imported fossil fuels. So increasing security of supply was probably the top priority for this interconnector. We also have a very – a relatively small market in Ireland and Northern Ireland and we don’t have the same level of competition that exists in other electricity markets. So the new interconnector should exert downward pressure on wholesale prices, providing direct access to Great Britain's larger system and enhancing competition in the Irish market.

And finally, probably the third driver behind the interconnector was to accommodate RES. So as I mentioned, we've very ambitious 2020 targets of 40 percent electricity from renewable generation, and the East-West interconnector is seen as a key enabler for achieving this target.

It follows the export – sorry, it lowers the export of excess power at times of over supply when generation from wind and other renewable sources outstrips demand. So by having the ability to export the power where it can reduce demand and make it financially viable for the – say the wind farms to build in the first place, we've been told anecdotally that curtailment in the five to ten percent region is enough to make wind farms not financially viable.

So in order to meet our 2020 targets, we need to keep curtailment as low as possible, and the East-West interconnector should assist in doing this.

So just looking at the choice of technology, and to my mind, what makes this project a smart project is the choice of technology, it was vitally important that the technology complemented and was appropriate for the particular characteristics of a small island system.

Of particular importance is its performance during faults, so being able to maintain voltage, enhancing the transient stability of the system, and to continue supplying active power during faults. Also its promise during frequency events is of importance.

Again, for an island system with a lot of non-synchronous generation, it's important that the interconnector could react quickly to frequency events. And this was the latest variant of HVDC voltage source converter technology, that's ABB's HVDC _______ represents the optimum whole-life techno-economic solution for this particular challenge.

So when the East-West interconnector was commissioned, it was at the forefront of HVDC voltage source converter technology, being the highest capacity system at the time. I suppose another key feature is the fact that it uses XLP cables working at plus or minus 200 kV. And at the time of commissioning, again, this was the highest voltage which such cables had been used.

And I supposed from an environmental viewpoint, the fact that there's no oils used in the cable manufacture, it's a much more environmentally friendly solution than maybe conventional oil/paper insulated cables.

So looking at some of the ancillary services which the interconnector can provide, by the fact that it is voltage source converter technology, I suppose the first one is that it can provide very fast, active power response for high and low frequency events. So it's much quicker than existing conventional generation on the system.

And this is hugely important, as I mentioned, in a system that's very _______ with a high proportion of non-synchronous generation. Another key feature of the scheme in terms of ancillary services is its ability to black start. So for example, if the Ireland or Northern Ireland or the GB systems experienced a major blackout, the interconnector can be used to provide a control power to the blacked out system, speeding up recovery of the grid, restoration of the grid.

And finally in terms of voltage control, not only can provide steady-state reactive power, but it can also help support voltage during faults, again improving the transient stability of the system. And again, a very important feature to have in a system where conventional generation, synchronous conventional generation is being replaced by non-synchronous, because the active power contribution during faults is much lower.

So just looking at the construction phase of the project, and in particular community engagement. So there were a number of initiatives that EirGrid undertook during the construction phase in order to develop and maintain good relationships with local communities. As mentioned there were very tight timelines for the project, and good community relations were hugely important for the success of the project in the timelines outlined.

So just looking at a number of the initiatives, so the first one, two full-time community liaison officers were employed to work with local councils, and this facilitated coordinated communications and interactions with local councilors and the wider public.

Local businesses and households were kept informed on installation works in a number of ways, through social media, leaflet drops, text messages, but in particular through a local information office. And this allowed members of the public to directly meet the project team to answer any queries as they arose.

And finally, just looking at one other one is engagement with primary schools. So EirGrid actively engaged primary schools along the route to promote engineering as a career, using the East-West interconnector project as a model to inform students about the challenges and satisfactions of engineering as a career choice.

So there are just a number of ways that community engagement – EirGrid engaged with the community in order to successfully bring the construction phase of the project about.

So at present, EWIC has been operational for just over two years, and clearly it's helped just by being there the security of supply in Ireland and Northern Ireland. But in terms of promoting competition, a study was completed in 2014 after the first full year of commercial operation, and this study indicated that there was a 9 percent saving in terms of wholesale electricity prices compared to if the interconnector wasn't present.

So this creates to production cost savings of approximately 170 million for that year, so clearly fulfilling this objective of promoting competition. It's worth bearing in mind, as well, that auction revenues and ancillary services revenues are helping to reduce the cost of this interconnector to the consumer, as well.

And in terms of reducing RES curtailment, so we can see from this example here how the East-West interconnector is accommodating renewable energy sources. So this particular example here is from October last. And we can see that about midnight on the 21st, the wind is quite high, so we have the red line here. So wind is approaching 2000 megawatts and demand is dropping down, due to night time, and it's approaching 3000 megawatts.

So at present in Ireland and Northern Ireland we have an operational limit which limits electricity from non-synchronous sources to 50 percent for operational security reasons. So in order to accommodate the high wind during a low demand scenario, you can see that the interconnector, the scale is on the right, went from 400 megawatts import to 300 megawatts export. So here we can clearly see how the interconnector's helping reduce curtailment on wind farms.

So in the first six months of operation, we're countertrading, so basically countertrading to reduce the curtailment to wind, 300 gigawatt hours was countertraded, thus helping to reduce curtailment of wind farms.

So just looking at lessons learned, I suppose as I mentioned previously, the choice of technology was key. It was important that the technology complemented and was appropriate for particular characteristics of both the Ireland and Northern Ireland system and the Great Britain system.

As I mentioned previously, of particular importance was its performance during faults and frequency events and the system services that it provides. And I suppose the latest variant of HVDC voltage source converter technology represented the best fit for the solution.

During the construction phase, developing and maintaining good relationships with the many and varied stakeholders was key to the success of the project. The project cultivated good relationships with local councils and regularly sought their advice, which subsequently led to very few problems we encountered, and this is particularly important giving – given the tight timelines of the project.

The final bit of lessons learned and best practice is regarding project management. So separate project managers were utilized for the Ireland side, Great Britain side and the marine works. And the clear split in roles worked very, very well, ensured focus on the overall completion of the project.

It's worth pointing out also that the complete scheme was designed to show compliance with ISO standards for quality, environmental and occupational health and safety.

So finally looking at next steps, I suppose following on the success from the East-West interconnector project, further interconnection has been planned between the island of Ireland and the wider European power system. So EirGrid already has signed a memorandum of understanding with the French TSO RTE, commissioning further preliminary studies on the feasibility of building a submarine electricity interconnector between Ireland and France.

So the studies that EirGrid and RTE have already completed shows that an interconnector between the two countries would be beneficial for electricity consumers on both sides, and it's worth pointing out that at the moment, in fact, marine seabed surveys for the interconnector are currently being carried out for the proposed interconnector.

	So that completes my presentation. I'd be happy to answer any questions that you may have. Thank you.
Host	Great. Thank you, Seamus, and thank you once again to all three panelists for those presentations today. We do have a couple of questions from the audience, that we will move on to at the moment and if there are any other questions from the audience, please feel free to ask them now and we'll hope to get through them all. So the first question is for all the panelists, and it's about cyber security. The person wants to know what practical problems regarding cyber security have any of you faced and how have you solved them. And then moving on, if you have any advice regarding cyber security for the audience. And this is for anybody who might have some experience there.
Seamus Power	Yeah, so this is Seamus Power here. Regarding the East-West interconnector project, cyber security wasn't really an issue as we had dedicated fiber which ran along with the interconnector. So from an East-West perspective, because we had dedicated fiber, cyber security wasn't an issue in that case.
Helfried Brunner	That's almost the same in Austria in our use cases. So for two reasons we did not consider that much cyber security. The first one, in the medium voltage network, we used the existing communications system and it's an internal system of distribution system operators were _______ already all cyber security as well as overall security issues. And in terms of low voltage network, we used the communications based on the smart metering infrastructure. And of course, we considered all security functions already implemented in the smart metering and did not – we were not focused on cyber security since we have been in a really pilot stage. And what we are currently doing is running a big Austrian initiative collecting all experiences from the individual and further projects on security, not just focusing cyber security, general security and setting up recommendations for a safe and secure reference architecture for future smart grid applications. Within the projects we didn't have a particular focus on security and also cyber security.
Host	Great, thank you. Very good.
Bo Normark	A comment. Make a comment from Bo here also, I think this is a very relevant question and I would say that if you look at the cases you have in the casebook, I mean, none of them has specifically addressed this issue, but I'm convinced it is an issue that you can expect that we cover more interest future generations of the casebook. Because it is for sure an _______ interest and like in Sweden, there has been I would say significant stress tests made on the grid based on the fact that it's an increasing concern about interconnectivity and about this data system. So I take it as a good hint for future topics of power in the casebook.
Host	Great. Maybe we'll consider doing a webinar on that at some point. Thank you. Next question, this one's for Seamus. Seamus, how do you see your project in view of the recently announced EU energy union. Is that going to affect it in any way, do you think?

Seamus Power | So I think that the – that makes the project even more important, the fact that we have good links to the rest of Europe. I suppose as I mentioned there in the next steps that we're looking at an interconnector to France, and I suppose increasing interconnection is very important, particularly for Ireland, the fact that we are kind of isolated from the rest of Europe.

Host | Great, thank you very much. This one's for Helfried. Helfried, to what extent have customers been involved in the project and related control?

Helfried Brunner | In the medium voltage networks, they haven't been directly involved since we just deal with the distributed generation owners and the network operators. But it was very nice and interesting in the low voltage system, as I mentioned, we included a lot of flexibilities in terms of converters and charging station at customer premise level. And that was a process we started very early in the state of the project to actively attract customers to join the project, and we didn't expect that it was as successful as it was finally. So there was also an additional, as I mentioned, funding subsidies for attracting people to put additional PV on their rooftops. There was a quite nice offer to use the electric vehicles for a year and finally with support, and that was very important, how to involve people is to have some _______ players and people who are in favor with the idea. And in all these low voltage field test areas, we had a very, very good relationship to the local mayors, which really supported us in attracting the people and in all three low voltage network areas, within two days, really two days we had the necessary amount of customers volunteering and taking part and actively part in the system. And it was finally very important for the acceptance of our activities, of what's going on in the local community, if the customers are really part of the game, so to say.

Host | All right. Good, thank you. Yes, community engagement I think is quite important and I know Seamus, you touched on that a little bit in your presentation, as well. Thank you for that, Helfried. Final question, Seamus again, what annual availability is expected from the East-West interconnector?

Seamus Power | So currently from the first two years of operation we have upwards of 98 percent. So quite high, along with the international standards, when you compare with other interconnectors. So that's what we're expecting. I suppose it's worth pointing out that we'll always consider the longer-term integrity of the asset, so we're not purely looking at the short-term availability. So we'd never put the interconnector at risk to keep the short-term availability high. So always thinking about the long term, this is an asset that'll be there hopefully for the next 40 years.

Host | Great. Well, that's all the questions we have at the moment. So before we wrap up the webinar, I'd just like to give all the presenters a chance to provide any closing remarks or final thoughts and then we'll move on finally to taking a poll. But if anybody would like to provide some last remarks, please feel free to do so now.

Okay, if nobody has any closing remarks, we'll move right on to a survey. So we have three short questions for you to answer, your feedback is very important to us, as it allows us to know what we are doing well and where we can improve. So if you'd go ahead and please answer the first question on your screen. All right, thank you very much. On to the second question. And final question. All right, thank you for answering the survey and that'll wrap it up.

So on behalf of the Clean Energy Solutions Center, I'd like to extend a thank you to all of our expert panelists, Bo, Helfried and Seamus, as well as to our attendees for participating in today's webinar. We've had a great 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 a recording of today's presentation, as well as previously held webinars. You'll also find information on upcoming webinars and other training events on that website. We are also now posting webinar recordings to the Clean Energy Solutions Center YouTube channel. Please allow about one week for the audio recording to be posted to the channel. We also invite you to inform your colleagues and those in your networks about solutions center resources and services, including 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 and thank you again to everyone.