Offshore Wind 101
May 15, 2013

Coordinator: Welcome and thank you for standing by. All participants will be in a listen-only line for the duration of today's conference call. Today's conference is being recorded. If you have any objections you may disconnect at this time. I'd like to go ahead and turn the call over to your host for today to Mr. Ian Baring-Gould. Sir, you may begin.

Ian Baring-Gould: Thank you very much, (Jose). Thanks everybody for this special Wind Powering America session which is focusing on a kind of introduction to offshore wind. Last week was the summit so we decided to break a little bit here and allow to do a kind of introduction to offshore wind energy and hope that through presenting this and also through the recording that we'll be able to have kind of a very easy reference for folks who are just getting into the offshore wind area and want to get a quick primer on the technology.

So we have two speakers today - one focusing on the technology and then myself focusing on the market. So it's with pleasure that Alana will be joining us to do the technology session. Before we dive into that, just remind everybody that questions are done through a written Q&A system. So if you look up at the top of your screen, you'll see a little Q&A to ask questions. Just hit that little Q&A and a little box will come up and you ask some questions.

We'll be doing questions for both of the sessions at the end of the hour today. So please type in your questions there and we'll get to them at the end. So without further ado I'd like to introduce Alana Smentek-Duerr who is a Knauss Fellow currently working with the Department of Energy Wind and Water Power Technologies Office. She joined DOE in February and is working in the implementation of the offshore wind demonstration projects

that the department announced earlier this year and will be ongoing for the next couple of years.

Alana's background is in engineering and she completed her undergraduate work in naval architecture and marine engineering from the web institute and then got her Ph.D. in ocean engineering from Florida Atlantic University. So certainly one of the people that coming from the marine science side that is supporting the Department of Energy in implementing this great new field of offshore wind technology - not really that new. That's what we'll get to. So without further ado Alana will provide us a technology overview of offshore wind. Alana.

Alana Smentek-Duerr: Thanks Ian for the introduction. As Ian said, I am Alana Smentek-Duerr and I'm a Knauss Fellow working in the wind and Water Power Technologies Office at the U.S. Department of Energy.

Today's presentation will give a brief overview of offshore wind technology. I'll try to provide some perspective of the industry discussing the evolution of offshore wind, the technologies used today and the innovate technologies that will allow for the offshore wind industry to grow.

Offshore wind power can play a key role in our nation's clean energy future. Looking at the wind speed map of the U.S. in this slide, you can see that most coastal regions have strong wind resources. In all cases, the offshore wind resource is better than the onshore resource. And 70% of the nation's electricity is consumed in the coastal and great lake states. Harnessing the local offshore resource would not only satisfy local electricity demands but would also revitalize port and domestic manufacturing industries.

As offshore wind technology advances, wind resources further offshore can be harnessed which would decrease visual impact and potential user conflict. Sorry. According to the Department of Energy's national renewable energy lab, the nation's potential offshore wind energy resource is more than 4,000 gigawatts which is four times the generating capacity of the entire U.S. electrical power system at this time.

Over half of that potential resource is in deep water which is considered greater than 60 meters. While all of this area cannot be developed when competing uses and environmentally sensitive areas are taken into consideration, harvesting even a fraction of this potential could create thousands of jobs, diversify U.S. energy supplies and provide cost competitive electricity to key coastal regions.

So what is the technology that will allow us to harness this resource? Looking at how wind turbine technology has evolved. 30 years ago wind turbines were less than 20 meters in diameter and produced less than 100 kilowatts of power as you can see in this picture right here.

Today wind turbines have grown to have diameter greater than 100 meters and are rated up to six megawatts. Transportation costs and logistics are beginning to limit the size of onshore wind turbines while offshore wind turbines continue to increase in size and capacity. By installing larger turbines offshore where there is a consistent wind resource, there is a potential to lower the cost of energy for offshore wind.

To get a quick snapshot of the state of the industry - as of the end of 2012, 62 offshore wind projects have been installed yielding over 4,000 megawatts of installed capacity. None of this capacity has been installed in the U.S. Of these projects, 59 of them are installed on fixed bottom foundations. Offshore wind

turbine drive trains vary between geared and direct drive however the industry trend is toward direct drive generators which I'll discuss later in the presentation. Thus far the experience of the oil and gas industry has driven the balance of plans which is everything but the turbine technology development.

And the turbines themselves are the marinized versions of their land based counterparts. However with the development of the offshore wind industry, new turbines are specifically designed for offshore use.

What sets offshore wind technology apart from its onshore counterpart is simplistically its installation in a marine environment. The water depths where wind turbines are installed drives the foundation selection and the engineering of the foundation. Offshore wind turbine installations are typically divided into three categories - shallow water, transitional depth and deep water. Approximately ¼ of the U.S. wind resource is located within shallow water regions.

The most common shallow water foundation is a mono pile. These are typically installed in depths less than 25 meters. The mono pile foundation is a steel pipe that is driven into the sea bed using pile driving or drilling techniques. In order to have a level platform to affix the wind turbine tower, the mono pile is fitted with a transition piece which is grounded to the top of the pile. The turbine tower is then bolted to the transition piece with the turbine installed on top of the tower.

The advantages of mono piles is that they are simple and easy construct compared to other foundations. Disadvantages include the grouting between the transition piece and the mono pile which in some cases have crumbled over time. Additionally the noise associated with pile driving and potential impacts to marine life are an issue that has come up. Finally scour protection

around the base of the turbine must be installed in order to maintain the stiffness necessary to support the pile.

Just a note - in the bottom picture you can see transition pieces which are these yellow foundations and then the mono piles which are staged for installation. Mono piles may be simple to construct however with increasing turbine size and weight, mono piles and their transition pieces are getting larger and heavier.

Another type of shallow water foundation is the gravity based structure. Gravity based structures are very heavy and typically made of concrete. They're installed in shallow water and balanced to provide a solid base for the wind turbine. The advantages of the gravity based structure are that there are no transition piece which is extremely heavy. And they can either be transported to the installation site by barge or they can be floated, towed out and balanced at the installation location.

Additionally the concrete structures require little maintenance. The disadvantage is that these are typically for very shallow water installation and the sea bed must be prepared prior to installation which typically includes dredging.

Severity of structures vary in shape and sizes can be seen in the picture on the left. The top picture are foundations from the Southern Bangui Farm in Belgium which was inaugurated in 2008. These foundations support five megawatt turbines. The picture on the lower left - as you can see - the foundations are much smaller because they are at a much shallower depth at the (Roadsandtoo) in Denmark. These were installed in 2010 and support 2.3 megawatt turbine.

The final picture on the right shows the middle wind farm in Denmark which was inaugurated in 2000. At the time it was the largest offshore wind farm with a capacity of 40 megawatt - each turbine rated at two megawatts.

The final type of shallow water foundations that I'll discuss are suction buckets. The base of this type of foundation is essentially a cylinder with an open bottom. Once the foundation is lowered onto the sea floor, a pump removes the water from the suction bucket and the bucket is pressed into the soil. Once the procedure is completed, the structure acts like a gravity based structure. The advantages of this foundation are the fact that there's no transition piece and no pile driving is required for installation. However the sea bed conditions must be investigated as rocks and soil conditions factor into the installation procedure.

Tube suction bucket foundations outfitted with meteorological instrumentation are to be installed at the Daugherty Bank Wind Zone in the North Sea off of the UK. One of these installations was completed in March of this year.

This is an example of a commercial scaled shallow water wind farm at the Horn Drive. The Horn Drive installation was completed in 2012 and is comprised of 80 turbines each rated at two megawatts. This farm is located off the coast of Denmark.

Moving into deeper water, transitional depth is typically classified to 30 to 60 meter water depth. However some of the transitional depth technologies have the potential to be utilized in water depths up to 100 meters. Approximately 1/6 of U.S. offshore wind resource is located within transitional depth regions.

The tripod foundation is one solution for the transitional depth range. Tripods are typically pile foundations driving three piles in the same pattern as the base of the structure. These piles can be pre-drilled using a drilling template or post drilled after the foundation is in place. There is potential for suction buckets to be used on each leg of the tripod instead of using three piles. The tripod has a wide base which results in high resistance to an overturning moment due to various loading on the foundation. However disadvantages include the hydro dynamic loading and the fact that the main joint is pretty complicated.

So far only six of these foundations have been installed and the images show the foundations that were fabricated and installed at the Alpha Dentes Wind Farm off of Germany.

Jacket foundations have been used extensively in the oil and gas industry. These structures can be installed in water depths up to 120 meters although the realistic deployment limit is around 100 meters. Leveling of these foundations is done at the sea bed and is not a function of the transition piece. Advantages of the foundation include the flexibility of the installation sequence, pre or post piled installation of the tripod and the turbine tower can be installed with or without the turbine already intact. And also the lightweight construction compared to the mono pile is a huge advantage for the jacket.

The main disadvantage is the welding complexity due to the number of joints in the structure. As you can see in the pictures, the jackets can vary in configuration. The top left photo shows that tripod structure which is used at the Clark Wind Farm. The top right photo shows the twisted jacket structure which is actually supporting a net mask at the Horn Sea wind zone although future twisted jackets will be designed to support wind turbines. The bottom

right photo shows jacket structures that are staged for installation and then the bottom left shows the jackets used at the BHS Wind Farm.

Fixed tripods and fixed jacket foundations have been installed at the Alpha Ventis Wind Farm in Germany. Each foundation supports a five megawatt turbine. The farm was installed in 2009 and began commercially operating in 2010 and was the first offshore wind farm for Germany.

As mentioned earlier, over half of the U.S. offshore wind resource is in regions with deep water. In order to take advantage of this resource, floating foundations will need to be used. So far only three floating wind turbines have been deployed globally and only two of these have been on the scale of megawatts.

Straddle high wind turbine has been deployed off of Norway since 2009. High wind users of far foundations which have been used extensively in the oil and gas industry to support a 2.3 megawatt turbine. As you can see in this figure that shows what the spar looks like under the water, the spar is a long and narrow foundation and has high enhanced stability. The high wind turbine is assembled in protected waters and then towed to its final installation location. It uses three long lines and anchors in order to maintain its position. This three point morning scheme has minimum sea floor impact.

While this technology is innovative, further innovations include the float and flip installation method which could streamline the installation process as the whole structure will be towed out horizontally on a barge. It would then be balanced and flipped vertically and then more into position. (Unintelligible) plans to deploy four three megawatt wind turbines in the Gulf of Maine in approximately 150 meters of water. Each foundation will reach about 80 meters below the surface.

Versatile Power's wind float has been producing power off of Portugal since 2011. The wind float is a semi-submersible foundation that supports a two megawatt turbine. Some submersibles like spars have been used extensively in the oil and gas industry. What is unique about the wind float is that it can be completely assembled onshore and installed without the use of onshore cranes. This has the potential to significantly decrease installation time and cost. Versatile Power plans on installing five six megawatt turbines off of the coast of Oregon and the installation depths will be greater than 300 meters.

Other floating wind concepts that are in development include the (Gloston Palistar) which is on the left here which is a tension link platform or a TLP foundation. A TLP uses the excess buoyant force in a space and the tension legs to hold the tension in place. The DCNS/wind submersible foundations appear on the right and these sway far foundations are also concepts that are in development.

Beyond the foundation technology, the trend in offshore wind technology has been moved from geared to direct generators. Geared drives failures contribute to high operations and maintenance or O&M cost. Direct drive generators have fewer moving parts and are more reliable than their geared counterparts. Decreasing the weight of direct drive generators is important for their success in the offshore wind industry as installation crane capacity may dictate the turbine weight limit.

Offshore wind turbines are designed to operate in complicated operating conditions. These operating conditions often drive technology and innovation. All offshore wind installations will need to withstand wind and wave load. Some installations may need to consider breaking wave and ice loading. In the

U.S. hurricane loading is also a factor that has to be considered. Changes to the sea bed will also impact engineering and design conditions.

Offshore wind installations are complicated and increasing wind turbine capacity which increases the rotor size, turbine weight and hub height does not simplify the procedure. In the U.S. this is a challenge because no offshore wind turbines have been installed. In Europe where the offshore wind market has developed there are vessels available for turbine installation however since no market in the U.S. has developed, there aren't any purposeful offshore wind installation vessels in the U.S.

In order to comply with the Jones Act in the U.S., U.S. vessels may need to be retrofitted or purpose built for U.S. offshore wind installation. Another installation issue is pile driving. Pile driving is a concern due to the noise levels it produces and unknown impact it may have on marine life. New installation techniques are being investigated to mitigate this issue. However many of these issues pertain to fixed bottom installations. Floating offshore wind platforms that are fully assembled in port have the potential to mitigate some of these issues.

Logistical challenges face the offshore wind industry in the U.S. Infrastructure to support O&M strategies, grid interconnection and developing a supply chain are integral in supporting this new industry. Additionally spatial planning and coordination are to be considered in wind turbine farm siding.

While this does not necessarily pertain to offshore wind technology, it is an example of the technologies that are available to support offshore wind development. A very common question is what kind of visual impact offshore wind farms will have. Advances in visual simulation technology have allowed

us to run computer models to predict the visual impacts of an offshore wind farm.

The image above is a pre-visualization rendering of the Horn Drive wind farms. And the image below is a post construction photograph of the same wind farm. As you can see, the visual impact simulation was accurate in its prediction of what the wind farm would look like from shore.

To wrap up, many solutions and technologies for offshore wind have been tested and proven in the European market. All of the technologies discussed today have been installed and are in operation in Europe except for the few floating concepts that I mentioned. However there are still risks associated with offshore wind. Larger turbines with greater capacity and innovative technologies that are purposely developed for offshore wind operation will not only reduce the technological risk but will also reduce the cost of energy.

With over 50% of the U.S. wind resource in deep water, innovations in floating wind turbine platforms - mainly the way they're constructed, assembled and installed will open up a resource that has not been commercially developed anywhere in the world.

The U.S. Department of Energy is committed to the offshore wind industry. In 2011 the Department of Energy along with the Department of the Interior set forth the national offshore wind strategy that set a goal of 54 gigawatts of offshore wind by 2030. To achieve the 54 gigawatts of offshore wind capacity, the strategy has two objectives - to reduce the cost of energy through technology development and to reduce deployment times and uncertainty.

The presentation given by (Greg Mathis) in the April Wind Powering America webinar discussed the seven technology demonstration partnerships that the

DOE is currently involved in. These projects are developing breakthrough offshore wind energy generation projects with the primary goal of achieving large cost reductions over existing wind technologies and to develop viable and reliable options for the United States.

With that, I'd like to thank everyone for participating in this webinar and if you have any questions, I'd be happy to answer them at the end of Ian's presentation.

Ian Baring-Gould: Great. Thank you so much Alana for that presentation. So the next phase of the webinar is looking at the market - the current market for offshore wind technologies in which I'll give a quick overview of what's happening worldwide, the cost and then the kind of deployment strategies and then look more specifically at offshore wind development here in the United States.

So as a brief introduction I'm a technology deployment manager at the National Renewable Energy Laboratory focusing on wind and water technologies and lead NREL's part of the U.S. Department of Energy's outreach and stakeholder engagement activities focusing on the appropriate deployment of wind energy.

And so talking about the offshore market as Alana indicated, most of the development thus far has been undertaken in Europe. And we can see here a global installation of about 4.6 megawatts or gigawatts - sorry - of offshore wind technology that has been installed up to date. As a reference, just this year we completed 60 gigawatts of land based installations here in the United States. So offshore wind installation is certainly a small percentage of total wind installations worldwide but is certainly a viable percentage. And as we'll see going forward, it has a much larger potential market that we'll see growing over the next number of years.

Through this next series of slides I'm going to talk about what we see in regards to offshore wind development both within Europe, U.S. and then internationally. In this slide we see focused on Europe but on one access the timeline of the date of commissioning of projects or planned commissioning of projects and then the estimated capital cost of those projects going up the other access. In the dots here - we see the dark blue are projects that are under construction - ones that are being - or sorry - that are installed under construction, contracted and approved.

And so here you can see that certainly in the early part of the decade just as installations were being installed, we saw prices that were quite low from an installed capacity perspective. The prices increased and then - as we can see - are leveling out in this 4,000 to $6,000 per kilowatt area with a fair amount of range and we'll talk about this a little bit later. The size of the dots represent the size of the projects that are being implemented. So earlier in the decade much smaller projects and then we're starting to see very large projects.

The bard one project that we see there - as we'll see in future slides - is installed in rather deep water and therefore has a higher cost than we see more readily in the other projects. On top of this we add the U.S. projects - the Cape Wind is the only one that is contracted. And then we have the Boca Island project that's been approved. But as you can see, they fall fairly much in line - a little bit higher but that's to be expected for the first U.S. wind projects that are going to be deployed but very much in line with what we're seeing in Europe.

Now we add Asia to the list and as you can see, the Asia projects are being installed or planned to be installed at a slightly lower price or certainly at the lower end of the spectrum that we see in Europe. Again, something that's not

too unexpected when we look at the different market sectors for land based wind and how that kind of plays out in the offshore space.

The installed capital cost of offshore wind technology is certainly higher and as you can see, there's a range of these costs. But if you start to break it out here, we see that instead of land based technology is where about 75% of the cost of the installation is actually the turbine itself.

In offshore installations the majority of the cost is actually the installation of the project as opposed to the actual turbine and the turbine only makes up about 32% of the project with the blue segment being the installation cost for the foundation support structures, electrical infrastructure and then the assembly transport and install and then the purple being all of the kind of efforts - the deployment efforts - that have a monetary impact. So a very different picture from the land-based technology that we're used to seeing.

We certainly understand that the price of offshore wind power is higher than land based but in Europe we've seen this development because of the reduced availability of land available for land based technologies and we certainly see the cost decreasing in regards to offshore wind power basically through these three areas - larger turbines with a higher capacity taking advantage of the very strong winds that we see off the cost. Larger wind farms being installed and that's something that we can do in offshore environments. And then the more deployment that we have of offshore wind technology will drive the cost down as we kind of saw in those previous slides.

So we certainly see all of these three things working together to reduce the cost of offshore wind. Some of the things we have to think about as we deploy offshore technologies is this list that we see here - clearly water depth - the

deeper the water, the higher the cost. The further away from shore you get, the higher the cost.

But then these other things come into play - the condition of the soil, the sea bed in which the turbines are installed, wave climates, extreme conditions which we have that are different from European tropical storms, ice - things of that nature - grid convertibility, the supply chain, competing uses for the land and we'll talk a little bit about that and then clearly the environmental impacts are something that needs to be addressed when we're looking at where we're sitting offshore wind farms.

Just to kind of provide a quick summary or reminder of what Alana presented in regards to the different technologies. We have the shallow technologies that Alana had talked about, the floating tethered and then the spar design as we get into deeper water. So just a quick reminder as we start looking at the next series of slides which in this case show distance from shore along the bottom and then along the other access depth. So higher depth projects in deeper water and then further away.

Again we're going to go through - these are the projects that have been currently installed - again primarily in Europe. And as you can see, they're fairly close to shore with the early projects being very close to shore and very shallow water. And then as the industry grows, we're getting into deeper water all of which is still considered shallow for the most part. And then as we continue with planned projects or projects under construction, again still a fair amount in the shallow water but projects being moved into this transitional water depth which require the different foundation designs as Alana talked about contracted projects and then approved projects.

So as you can see, as the industry gains experience and expertise, we're certainly moving further away from shore and we are moving into deeper water depths but with a very strong concentration of projects in this relatively near shore and relatively shallow waters.

And then lastly adding Cape Wind again - the U.S. project that has been approved and then the demonstration floating projects appear in the upper corner with their ability to be installed in very deep water. But again, they're demonstration projects and so they're happening relatively close to shore.

Looking into the future of offshore wind development, it's certainly strong as we look forward. This map again shows Europe but with a summary of all the projects that have been approved as compared to the ones that have been installed which was the previous one. So we have about 16 gigawatts of projects that have been approved with Poland just jumping into the wind market with a lot of area in here that can be developed for offshore wind. So we certainly see lots of expanded growth in Europe going forward.

Looking at Asia - lots of expected growth and some very large targets for offshore wind deployment. China at five gigawatts installed by 2015 jumping up to 30 gigawatts in the next five years which is very impressive due to the Fukushima disaster in Japan - a very strong push to the deployment of offshore wind. And because Japan doesn't have very much shallow water, they have a very strong focus on deep water floating technologies. So we should see a lot of development in Japan going forward.

South Korea have a five megawatt project but expect to get up to or have plans to get up to two gigawatts by 2019 and also Taiwan has a pretty strong program looking at development going forward as well. So as you can see, the development chain for offshore wind in the pipeline is very impressive going

forward. This tries to summarize all the projects that are kind of the status of the offshore wind market. We can see the installed at 2.6 under construction - I'm sorry - 4.6 under construction - another 4.5.

But the projects that are being permitted and planned brings the total pipeline thus far up to over 200 gigawatts of potential capacity that are currently in the pipeline and again, referring back to the total installed capacity of onshore wind in the United States of 60 gigawatts. We're talking three times that amount that are in the pipeline for offshore wind development. So clearly it's a strong market going forward.

This plot just shows the size of the turbines going forward and Alana kind of alluded to this in her presentation. But we certainly see larger rotors and higher hub heights and bigger turbines going forwards as the technology develops and as turbines are being developed strictly for the offshore wind market and that's a clear indication of going forwards.

We also see that many more foundations types are going to be designed. Alana said that most of the installations thus far are mono piles but as we see the market progress, we're moving towards expanded use of the jacket foundations, the tripod foundations and right now in the very near term - not much in the floating space - but we certainly see that that will increase over time as the market continues to grow and we're pushed into deeper water.

Currently right now Siemens dominates the offshore wind market with Vestis following very closely behind. But as we see for the projects that are being planned in the near term a very broad expansion of the wind turbine industry moving into this area with Repower, Arriva and others making very strong pushes into the offshore wind market as we go forward. So we certainly see lots of the wind industry stepping into the offshore market and making -

understanding that it's going to be a much larger market going forward and continuing to want to be part of that.

Alana talked about the United States and the great wind potential that we have here. Another overlay of this is certainly population density. And if you look at in regards to why the United States is going to end up doing a fair amount of offshore wind development and that's because of the proximity of people in coastal areas - their need for electric service going forward and in the proximity to the fabulous wind resources that we have along both coasts - the great lakes and the great lakes.

So we certainly see a strong interest in offshore wind development because of this proximity. Alana had mentioned that most of the resource that we have is deep water. So just over 60% with the other splits between shallow and transitional which is a clear indication of the U.S. interest in going towards or doing more research in the deep water floating technologies which Alana alluded to in the demonstration projects.

It's also interesting to note that the higher cost energy areas are in coastal areas and in areas where we need deep water technologies. Most notably California and Hawaii have relatively high power costs. And so that's certainly a reason to have more interest in the floating technologies as we go forward.

Alana showed a portion of this slide before but this shows the different areas where Boehm has identified offshore areas for wind development as part of their leasing program - so areas off the coast of Massachusetts, Rhode Island, New Jersey, Delaware and Virginia - Maryland and Virginia - all are being designated for offshore wind. So we'll certainly see expanded development in

offshore waters and a lot of interest in companies by companies in developing projects in these areas already.

The kind of considerations that we have that are different in the United States as I've been alluding to the need to develop deep water technologies for the great lakes, the west coast and then areas in Maine and New England are all going to face the requirement to develop deep water technologies. We have fresh water ice which is something that we have to worry about primarily in the great lakes area. It's a little bit different than what we see in Europe.

And then we have to deal with tropical storms in the kind of Mid Atlantic and Gulf Coast areas as we look at offshore wind development in those areas. So some different technologies that we're going to need to address to really open the markets for offshore wind development here in the United States.

Some other things that are certainly of concern so we'll have to address as the U.S. market goes forward. Marine animal populations and I have another slide of these. The European studies suggest relatively minimal impact but we require a fair amount of U.S. studies to really understand what those impacts are going to be and then what mitigation strategies there are. Visual effects - so coastal residents near offshore wind facilities will see these and that will have to be addressed from a visual standpoint.

Clearly property value's another thing that is of interest for offshore wind. Probably a lesser degree than we see with land based technologies just because the visual impact is - the turbines are generally farther away. But we haven't done extensive studies in regards to what the impact from a property value standpoint offshore wind development will be and to a degree that's going to be very hard to do until we have at least a couple of projects that have been installed.

Noise is clearly an issue in regards to the primarily the installation of the turbines, the pile driving in shallower waters. Less of an issue we believe once the turbines are already operating but certainly something that will have to be considered. The impacts of tourism is certainly a concern for development. The European results have been actually pretty supportive of this and tourism industries have grown up around the deployment of offshore wind technologies but the evidence is rather ambiguous at this point and we'll certainly have to see whether that's going to - how impactful that will be in the United States.

Marine safety is clearly one in regards to our extensive use of our coastal waters for many, many different things and so how all the organizations work together to address the competing uses for our coastal area clearly is an issue that needs to be addressed going forwards as we work to deploy more offshore wind technology.

As I mentioned - the environmental impacts are something that a fair amount of research is ongoing but here's just a list of the different issues that need to be addressed as we look at expanded offshore wind development - protected sites and species, the ecology of the sea floor in the areas where offshore wind will be deployed, fisheries, marine birds, mammals and the impacts not only of the installation of the turbines but also their operation and the increased ship traffic in the area of the wind turbine for maintenance and things of that nature.

Sediment flows, the development and implementation of coastal planning processes, clearly the contamination of the sea bed and then water quality are all issues that need to be considered and a lot of research going into all of

these areas but more research is clearly needed as this market expands. So with that just in summary and then we'll have a bit of time for questions here.

As I think is very clear from both Alana and my presentations - the European market is very clearly the dominant one where a lot of experience being gained and a lot of learning taking place in regards to the deployment of offshore wind technologies. The Asian market promises lower costs as those initial graphs showed about the planned pricing for the projects going forward but it really has yet to be demonstrated and so we'll see how that - whether those lower cost trends actually come through.

Lots of potential development here in the United States with a couple of projects being very close to deployment. And so we're very excited - very excited to get the first steel in the water as they say for the offshore wind industry. As pointed out in regards to most energy, coordinated policy that's stable is clearly needed to offset the higher initial cost and push the drive for the development of offshore wind energy.

A robust project pipeline is really needed to encourage the investment that it's going to need to lower the cost of this technology going forward and then as always the case, the first adopters - the first projects that go in the water - are of high cost but then as the projects are installed, better understood then the risk in the implementation of new technology decreases and the cost of the technologies go down.

So with that I'll complete my presentation and we'll open up the floor to questions. We have a few questions that are out here but again I would encourage people to ask more questions. Just as a reminder to ask a question, go up to the Q&A bar up at the top of the screen, hit that and you can type in your question and then we'll respond to it here.

So the first question I will provide to Alana and this is provided by (Brenda Betty) and this is regarding the guide wires under the water. Has any monetary fund to determine the adverse impacts of marine animals and other sea life? How prevalent is the mode of stabilization? Alana if you want to take that then I can add to it.

Alana Smentek-Duerr: Yes, sure. I can take that.

See when I think of guide wires, I think of actual stabilizing wires that are taught. But I'm not sure if this question is regarding just mooring lines which are often…

Ian Baring-Gould: It's mooring lines I think is what (Brenda)'s referring to.

Alana Smentek-Duerr: And so when it comes to the mooring lines, because there have only been two floating platforms that have been installed globally, there hasn't been a whole lot to study so far but it's something that can definitely be studied as the first commercial scale products in the U.S. are installed. And mooring lines have been used in oil and gas and there could be entanglement issues but again, this is something that can be studied in much further detail as the floating turbines come online.

Ian Baring-Gould: Yes, the experience generally speaking based more on the oil and natural gas is the mooring lines are under a great deal of tension. And so entanglement issues are probably very unlikely. Again, more study needs to be done on this but depending on exactly the configuration the mooring lines are under a fair amount of tension.

Another question for you Alana - what size in weight limits do you see that would limit the deployment of offshore direct drive wind turbine generators?

Alana Smentek-Duerr: So the limiting factor - yes there's a weight limiting factor that will be dependent on offshore cranes that are available. But I think the main limiting factor are the cranes that are actually available. There aren't as many heavy lift cranes with the capacity to not only lift the capacity of the generator itself but to the height that it needs to be lifted.

And that's really more the crucial issue is the fact that with the increased rotor size, the hub height has also increased. And getting such a heavy piece of equipment up to that hub height is becoming - is being limited by the ships that are available.

Ian Baring-Gould: Okay. A question from (Jennifer Rinker) and this one I'll take. And Alana if you want to follow-up, that makes sense. How important do you think wind turbine reliability is in the feasibility of wind energy and are turbines breaking down too often?

So in regards to the offshore wind market, turbine reliability is critical and one of the large efforts that is underway to bring down the cost of offshore wind technology is a lot of advanced sensing and things of that nature so that you can monitor the operation of the wind turbines, troubleshoot the turbines from land base before you have to send a boat out to do the repair and that is really driving the reliability of or the increases in reliability of offshore wind technology.

From a land base perspective turbine reliability is actually quite good and we use a term of art in the industry called availability which indicates whether the turbines are available to produce power when they should be. And turbines in

the land base sweep are 98, 99 or 100% available saying that they are available to produce power almost all of the time.

And so from a land based perspective that's very good. From an offshore perspective we have to be able to do better than that in regards to the mean time between failures and then once a turbine failure occurs, how fast can we get it repaired. But that is a critical issue as we go forward with offshore wind technology.

Alana do you have a follow-up in regards to that one?

Alana Smentek-Duerr: No, I think you covered it pretty well.

Ian Baring-Gould: Okay, from (John O'Sullivan). How much impact do the offshore collection and transmission networks have on future progress? Will farms continue to be integrated on a project by project basis? Do you want to answer that or should I?

Alana Smentek-Duerr: Can you cover that Ian?

Ian Baring-Gould: Yes, certainly. The offshore collection and transmission systems are all pretty straight forward and are being developed quite naturally with the wind projects. One thing that we're certainly seeing is that as projects get further and further offshore the need to develop the transmission infrastructure to get that power back to shore is I don't want to say is becoming a limiting issue but it's becoming something that we look - that is being looked more closely at and whether it makes sense to use AC or even DC transmission as we get 100 miles offshore.

It's something that we're certainly - that the industry is certainly looking at and investigating because the further you get offshore, the longer that transmission line is and that becomes a higher cost in regards to the development of the project. So it's certainly something that people are looking at and people are looking at both AC and then two different versions of DC power conversion to get the power back.

There is a fair amount of work kind of planning or consideration in regards to large offshore grid networks primarily using DC both in Europe and then the Google deepwater - if I remember correctly - proposal to put a DC line off the Mid Atlantic coast would be an example of the implementation of a connector system that would use one large DC line that would connect a bunch of different wind farms as well as move power from different parts of the country. So that's certainly something that's being addressed and will lower the cost of projects as we go forwards.

A question from (Simon Meehan). What ships will Cape Wind be using to install their projects and then how are these working with and around the Jones Act? Do you have an answer to that?

Alana Smentek-Duerr: I don't know specifically what ships they're planning on using. I know one option that has been discussed is using a European installation heavy lift ship and then using U.S. flag speeder ships to go in and out of port to bring out the mono piles and the transition pieces but I don't know what their specific scheme will be.

Ian Baring-Gould: Yes, I'd follow that up. That's certainly something that has been floated - no pun intended - as a way not to get around. It's complying with the Jones Act but using European flagged installation vessels that actually don't ever go into U.S. ports and then U.S. ships to supply those which is actually very common

in Europe that the installation ships actually stay out at the wind farm and are just fed parts by feeder ships.

Another question - this one from (Richard Neal). Would you consider the market too early for wind data acquisition for the East West Wilmington lease area with my offshore facility - the Frying Pan Tower 25 miles off? I am interested in using it for data gathering.

That's a hard question. Why don't we take that offline and (Richard) if you want to email us, we might be able to put you in touch with the proper people in Boehm but I'm not sure the details of how that would work.

Another question for (Cindy) - from (Cindy Flower). How closely are you working with Boehm and other agencies on identifying areas that are suitable for offshore wind energy? Alana do you want to take that one?

Alana Smentek-Duerr: Yes. I mean were - Boehm has been the agency that has identified the areas that - the wind energy areas along the east coast and they're continuing to develop those. We've been working with them in partnership on the science needs, the resource assessment and baseline data collection. We've been working in partnership to develop those kinds of plans but they're doing the actual - the wind turbine - the wind area. They're choosing those wind areas. That's their agency.

Ian Baring-Gould: Okay. From (Dee Dillard) what is the experience with equipment durability? What are the most serious challenges in equipment service, life and reliability? Do you want to take that one or I can?

Alana Smentek-Duerr: You can take that one.

Ian Baring-Gould: Okay. So I think the biggest issue that we've seen in the offshore market is the early projects were really taking land based technology and deploying them offshore and the industry has really shifted over the last number of years to offshore wind technology or to wind turbines that are designed from the drawing board for the offshore environment. And so I think that is probably the biggest experience gain.

I mean early on there were certainly problems with generators and with power electronics and things of that nature that were applied but I think most of those are being worked out. And so we're certainly seeing different challenges. Alana you alluded to the issues with the grout in some of the towers. It actually wasn't the grout from my understanding but it's the doing new things in new environments, you always learn new things. And so it's that kind of birthing issue that we're seeing that has the biggest challenges. But there isn't kind of a core issue that I think anybody is having that says the weak link is this piece of the equipment.

Let's see. From (Tom Panelas) - is shifting wind more of an issue offshore than land based? Actually no, it's less of an issue. One of the good things about offshore wind is it's very consistent and then the sheer profile is actually much reduced compared to land based. So the offshore environment from a wind perspective is a lot cleaner than the resource that we get on land based. So that's actually nice and makes it a little bit easier.

A question from (Dan Betties) I believe. The European capacity numbers are interesting. Do we have any evidence of installations in Russia or the CIS regions? I don't know of any installations in that area or data coming from those. Alana do you have any?

Alana Smentek-Duerr: I don't have any.

Ian Baring-Gould: Okay. So I don't think there's much development in those areas at all.

Any applicable standard for energy integration to the grid from offshore production? I don't think there's any standards that are independent or different than the land based. So we're building off the experience - the extensive experience that oil and natural gas have had in the installation of technologies or the installation of equipment offshore.

So there's a fair amount of work that's been done but I'm not sure if there are applicable standards for the collection network as being different than any underwater installation. And then certainly the integration - once you get to land based, that's all covered by the NEC and FERK and all of those guys. There's nothing different there.

People are talking about the jobs that would be created by a U.S. offshore development. Is the cost of labor a major factor? I'm not actually sure but the department will be releasing very soon a number of fact sheets as well as a detailed study on the job impacts or potential job impacts from offshore wind development. And I am not sure - I'm pretty sure in those reports we get into - we certainly get into the jobs - the jobs creation - the economic impact. And I think those reports will also get into the cost of labor and those difference but I don't have any numbers in that regard. Do you Alana?

Alana Smentek-Duerr: No, I don't.

Ian Baring-Gould: Okay. A question maybe for both of us. Has DOE modified its goals for U.S. offshore wind energy? The 2001 strategy has 45 gigawatts by 2030 and (James) thinks 10 gigawatts by 2020. Are there more updated expectations perhaps more realistic projections given its project to date?

I can take that Alana or you can.

Alana Smentek-Duerr: Yes, you can take that.

Ian Baring-Gould: So no, there haven't been any updates at this point though DOE - the Department of Energy Wind and Water Power Technologies Office is just starting another round of studies similar to the 20% study which is where that 45 gigawatt number came out of and that's being undertaken now in collaboration with a whole host of partners including the American Wind Energy Association. And so we think we'll get kind of updated numbers in regards to potential deployment for both land based - well land based offshore - and distributed technologies as part of that report.

So that process is just being kicked off now and I'm not sure what the timeline is but the numbers of the 45 - I'm sorry - 54 gigawatts by 2030 are the only numbers that we have at this point.

Another question - a question from (Betsy Nicholas). How can the national ocean policy help with the need to work towards a stable coordinated policy for offshore wind and understand better the context within which wind is being cited? I'm not sure if I can answer that question. Alana can you?

Alana Smentek-Duerr: Yes, I have - I have someone helping me on this end. I have been told that the national ocean policy - while it creates new goals - does not plant existing - the existing mechanisms for citing offshore wind and the initiatives under the national ocean policy can increase our understanding of the current and future ocean activities and then which will help off shore wind sitting in the future.

Ian Baring-Gould: Right. And then lastly a question from (Jennifer Rinker). What do designers for offshore wind turbines focus on that is different from onshore conditions? Generally speaking it's a whole host of things because the offshore market ends up - has a number of different factors - installation, the wind conditions.

So I'm not sure if it will be kind of a cheap answer. It might not be all that fulfilling but basically they start from scratch and they use all of their expertise based on land base but design at least the turbines that are coming out now really to focus on the offshore market in regards to the key issues that we see offshore which are the need for higher reliability though it's harder to get staff out to the turbines to be able to do maintenance, the high cost of installation and the limits that we have in regards to the installation of turbines in that kind of harsh remote environment, the push to bigger turbines and much larger rotor diameters even though they're installed on lower tower heights.

So to a degree, the turbines that we're seeing generated now are really cut from new cloth and so the designers of those technologies are going back to the drawing boards and starting from scratch for the installations. And that is all of the questions that we have.

So since we're a few minutes over, I'm going to wrap up here just to say thank you to everybody for joining us. A recording of this webinar will be made available on the Wind Powering America website. It usually takes us about seven days to get the webinars up there.

The upcoming webinars that we have for the Wind Powering America webinar series in June is going to be on wind turbine supply chain and then July on wind turbine manufacturing. So please tune in if those are of interest to you going forward and then certainly if you felt this was educational and

want to pass the link off to other people, the webinar will be - it has been recorded and will be made available.

If you have any questions in regard to this or future webinars, you see my email. There is a second one but Jonathan Bartlett runs Wind Powering America program out of the Department of Energy and then also Suzanne Tegen and clearly a special thanks to the Department of Energy for Alana's participation in today's webinar but also the Department of Energy sponsors this webinar series. And so we're thankful to them.

So thank you all for your participation and look forward to hearing from you on future webinars. Thank you very much and have a great day. Bye.