The PowerShift Atlantic Smart Grid Demonstration of a Virtual Power Plant

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Webinar Panelists

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Praveen Rosario	System Integration Lead, PowerShift Atlantic, Stantec Consulting, Ltd.
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Sean Hello everyone. I'm Sean Esterly with the National Renewable Energy laboratory and welcome to today's webinar which is being hosted by the Clean Energy Solutions Center in partnership with the International Smart Grid Action Network also known as ISGAN. Today's webinar is focused on the PowerShift Atlantic smart grid demonstration of a virtue power plant. One important note of mention before we begin our presentation is that the Clean Energy Solutions Center not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center resource library as one of many best practices resources reviewed and selected by technical experts. Some of the webinar features that you have for today, you have two options for audio; you may either listen through your computer or over your telephone and if you choose to listen through your computer please select the "mic and speakers" option in the audio pane. Doing that will just help eliminate the possibility of any feedback or echo and if you choose to dial in by telephone, please select the telephone option and a box on the right side will display the telephone number and also the audio pin that you will need to dial in. Panelists, just a reminder that we ask you to mute your

audio devices when not presenting and if anyone is experiencing technical difficulties with the webinar today, you may contact the go to webinar's help desk at 888.259.3826.

We encourage anyone from the audience to ask questions at any point throughout the webinar. To do so just type your question into the question pane and it will be submitted to me. I can present those to the panelist during the question and answer session following the presentation. If anyone is having difficulty viewing the materials throughout the webinar portal, you will find PDF copies of the presentations at cleanenergysolution.org/training. Or, you may follow along as speaker presents. We will also post an audio recording of the webinar to that site within about a week of today's broadcast. Then in addition to that, we will be posting the webinar to the Solutions Center YouTube channel. Where you will also find many more informative webinars as well as video interviews with thought of leaders with clean energy policy topics. Today's webinar agenda is centered around the presentations from our guest panelists. We have Jennifer Hiscock, Michel Losier, and Praveen Rosario. And these panelists have been kind enough to join us to discuss the PowerShift Atlantic Research Project. A collaborative research and demonstration initiative, that's focused on finding more effective ways to create wind energy into our electricity system. With demonstration programs for residential and commercial customers underway across the maritime provinces in Atlantic Canada. Before our speakers begin their presentations, I will provide a short informative overview of the clean energy Solutions Center initiative. Following the presentation, you will have the question answer session and panelist can address questions submitted by the audience, followed by closing remarks and a brief survey.

Now this slide provides a bit of background in terms of how the Solutions Center came to be and the Solutions Center is an initiative of the Clean Energy Ministerial and is supported through a partnership of UN Energies. It was launched in April 2011 and is primarily led by Australia, the United States and other CEM partners. Some outcomes of this unique partnership includes support of developing countries through enhancement of resources on policies relating to energy access, no cost expert policy assistance and peer to peer learning and training tools such as the webinar you're attending today. And there's four primary goals for the Solutions Center, first goal is to serve as a clearing house of clean energy policy resources, second is to serve to share policy best practices, data analysis tools specific to clean energy policies and programs, and third is to deliver dynamic services that enable expert assistance, learning and peer to peer sharing of experiences and then lastly the Center fosters dialogue on emerging policy issues and innovation around the globe.

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

an overview of one of the marquis features that the Solutions Center which is the Ask an Expert. And ask an expert is has established a broad team of over thirty experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost. So for example, in the area of demand and policy evaluation we are very pleased to have Bruno Lapeloni, vice president of and co-founder of Inter Data serving as one of our experts. So if you have a need for policy assistance in demand or policy evaluation or any other clean energy sector, we do encourage you to use this service. Again, it's provided to you free of charge. So to request assistance simply submit your request by registering through our Ask an Expert feature at cleanenergysolutions.org/expert. And we also invite you to spread the word about this service to those in your networks and organizations. So, in summary we encourage you to explore and take advantage of the Solutions Center resources and services including the ask an expert technical assistance, the data base of clean energy policy resources, subscribe to our newsletter and then participate in webinars like this one.

So now I would like to provide an introduction for today's panelists, the first speaker we will be hearing from is Jen Hiscock who is a science and technology advisor for Natural Resources Canada, where she works on smart grid development and the integration of renewable and distributing energy resources. Our second speaker today after Jen will be Michel Losier, the program director of PowerShift Atlantic. Michel is also the director of customer engagement for reduced and shift demand at New Brunswick Power Corporation. Our final presenter is Praveen Rosario and Praveen is the systems integration lead for the PowerShift Atlantic project through Stantec Consulting. So with that, I would like to now turn the webinar over to Jen.

Jen Thanks Sean. So before we get started with the PowerShift Atlantic Project presented by Michel and Praveen I wanted to give you a bit of appreciation to where this project finds itself within Canada's activities and programs and support of Smart Grid and also within the international Smart Grid Action Network. So, for Canada you can find a fair amount of information in the report we published last year, Smart Grid in Canada 2012 and 2013 you can see the link at the bottom of the slide here and we've been able to get information on projects across Canada with a number of different funds from political and federal levels, but what I'm going to talk about today is the first two funds that you see listed there under natural resources Canada. So we have the Clean Energy Fund and the Eco Energy Innovation Initiative, the ecoII and together, they provide over 60% of the funding for publically funded smart grid projects in Canada. So for the Clean Energy Fund, these are demonstration projects where eight of them are specifically looking at smart grid applications with over 61 million in smart grid funding. Then the Eco Energy Initiative also funds R and D projects and some advanced studies ahead of larger demonstrations. So together, you are looking at 13 demonstrations and 4

research and development projects and 2 studies that make up over 8 million in funding and over 210 million in total project value.

You can see the links at the bottom of these slides for more information on all of those projects and, something of note that might be interesting for international partners is that these projects include 5 years of completion monitoring so that means that we continue to get data out of these projects following their completion to be able to make observations on the influence they have if any on market development, policy development and regulatory development.

So I grouped these projects from the funds into different categories, the first one is looking at renewable integration and storage and you can see there is a fair bit of activity across Canada in those aspects. The second area I'm looking at is grid automation and virtual power plants with which is where we find the PowerShift Atlantic Project led by New Brunswick Power. These project categorizations I provided aren't completely clean cut, you could argue that some of these projects could be more storage or they could be more grid automation but this just gives you a sense of where some of the focus is in Canada.

The third area, I looked at the demonstrations is, electric vehicle integration and smart building integration, where you can find more information on these, particularly the clean energy fund project that has been in place for longer, through the links online.

In terms of research and development, these areas are currently focused on storage, micro grid controls and demand response alone with their applications to virtual power plants. And then to ISGAN, as Sean mentioned this is another initiative with the Clean Energy Solutions Center, so it was born through the Clean Energy Ministerial and then became one of the implementing agreements under the International Energy Association, and Chemnet Energy with Natural Resources Canada is the official signatory to that implementing agreement. So, we represent Canada at that level. We joined 24 other countries in ISGAN, and the incitation is sent out to other countries, we are always looking for adopting new members to ISGAN, and the focus is very much on getting information out of the experiences from these different countries, and turning it into policy, advice and advice for program managers and developers and practitioners as well.

The way that ISGAN organizes its work is into annexes, where the first 4 foundational annexes and then the next 5, 6, and 7 annexes focus on more specific capabilities such as research on standards development through the R and D networks and specialized national labs. So the work that this is a product of is annex 1 and annex 2 looking at the smart grid inventory and the smart grid casebook studies. In each case the material we produce under these different annexes they are trying to take things that we already have at an international level in a sort of abstract or rough frame work idea

and turn it into specific applications and policies that we can see in our various levels of government and cities around the world.

So you can find further information about the PowerShift Atlantic project that we are talking about today within the latest casebook that has been developed on demand management available at the link you see provided and it's also one of the many projects listed from the 25 countries within the ISGAN smart catalog grid then became one of the for the that we've got 4 or 5 sites, 3 through the smart building integration project and again, you can see is getting smart grid catalog and that gives you a sense of where a lot of the global investment is going. With that, I'll let Michel explain more about PowerShift Atlantic.

Sean Just a reminder Michel that you're still on.

Michel Thank you. Okay we're good?

Sean Yes.

Michel Okay good thank you. I apologize for that where just getting started here. Thank you again. One of the things that I want to get started with is, these projects and specifically with what we are talking about with PowerShift Atlantic is these projects are 80 to 90% customers, 10 to 20% technology. As an industry most of our projects in the past have been probably have been reversed. A lot of technology for customers in the end but with this virtual power plant this intelligent load management starts with customer's homes businesses and industry. Therefore, it's a lot about the customer and less about the utility so we started the other end and worked our way back. So nothing against technology folks, I think they are all important. It's just really a complete shift in the transformation of the way of thinking as a utility.

So yes getting in to PowerShift Atlantic it's an interesting presentation here to discuss. Wind integration by load shifting we're in the Atlantic provinces, Eastern Canada. We got great wind regimes and the ability to cap some of that wind obviously there are limits to how much wind we can bring on to them at one time based on dynamic of the system. So looking at where we are relatively speaking total wind in Canada is about 8200 to 8100 megawatts of that order. Which, started in about the year 2000, and has ramped up ever since. That will about double in the next 5 years. Today it represents about 2% of our total energy 63 being hydro in Canada 15 % nuclear and the rest so this represents about 2 % of our total energy picture.

If we look at the Maritime provinces, you are looking at the order of 800-850 megawatts of wind power. On a peak of about 5200 megawatts in the Maritime or around 2200-2300 megawatts. So we are getting upwards of, on a windy day, 40-50 % at any given time. Which is a significant penetration of wind for anywhere in North America. So a project like

PowerShift Atlantic allows us to look at solutions to better integrate the wind and integrate more wind as we move forward on the road.

The project's visions and goals is to determine if shifting patterns in energy consumption through load shifting and enable utilities to more effectively integrate renewables such as energy and wind. Is load shift cost effective and reliable? So we look at hot water heaters, thermal storage and energy management systems and buildings. How does load shift perform in sync with system balancing? Forecast and wind power, we have to stay ahead- 10-15 minutes ahead, and understanding the customers role with the new technology.

Today we have in the order of 1270 customers and 16 megawatts of connective load working on a virtual power plant today, installed. So that's what we are working with and a lot of this load is load that can be shifted, so customers can be kept business as usual, but can be shifted in correlation with where the wind is blowing or a better time for the overall system performance.

Next slide. The participants working with Natural Resources Canada, a co-founded MB power a lead proponent with Nova Scotia Power, Maritime Electric, St. John Energy, University of New Brunswick, system operators. The project manager at integrator, Stantec, Accreon and Leidos, the aggregators, you might have seen some of these names these corporations. Integral Analytics, End use connectivity, Seqentric, Dimplex, Tantalus, BellAlliant, Steffecs, and Enbala. We start seeing or thinking words like integration, standards form, and open platform and these are the kind of players that are starting to get intertwined in what we would call a virtual power plant and Praveen will talk more about that.

Moving on, NB Power and Atlantic Canada, New Brunswick Power, vertically integrated utilities 330,000 customers in Eastern Canada. We peak at 3100 megawatts, we have a diverse generation supply, we have a 700-megawatt nuke, we have 900 megawatts of hydro, running about 30% capacity factor, we have about 300 megawatts of wind on our system, but we also have Prince Edward Island and Northern Maine. So when we look at that peak of 3100 megawatts, we have 1500 megawatts of electric baseboard heat on peak, and approximately 150 megawatts of hot water on that peak of 3100 megawatts. That's potentially shiftable load on down the road or a portion of that is. But we have a very peaky system in the winter because of that baseboard heat. We peak in the summer around 1600-1700 we will mid at around 950. A week ago when we had relatively cooler nights, we were around 950 megawatts. But, if you have a 700 megawatt nuke on, and we have 300 megawatts of wind, and say, 300 megawatts coming down the river, we have 1300, perhaps our coal plants at minimum are 1500, on a 1000-megawatt night, we have to manage those renewable very intelligently to get the maximum value for them. Storage becomes a huge asset because wind obviously will work with the dynamics of your

system- your max and mid loads, and what's actually taking place because we are not curtailing nuclear, and that's how we are operating the system.

But if you look at this slide, the entire region peaks at about 5200 megawatts, mids around 2200–2300 and we've got in the order of, I think that's 900 megawatts of wind today between the three provinces. We are sitting at about 8 % in New Brunswick and I believe Nova Scotia is about 10% wind energy as a total today. So Good potential, potential for more, but the need for better products.

The Typical home in New Brunswick 60 % space heating and cooling so, water heating about 20 % so your average home in new Brunswick because of the electric base board heat and hot water heat is 70-80 % of electrons flowing to those homes just for those two areas. Well, there is huge potential there and New Brunswick Power, we have a rental program for 220,000 electric hot water heaters, we have about 80 % of the market captured. Well, that's a huge opportunity. Some of these customers we have connected on hot water, they get hot water and it's business as usual, we are just heating that hot water at a better time for the overall system. So I think this starts to demonstrate in New Brunswick per se, why there is a huge business case and potential for this type of product and for the project PowerShift.

So we will move on. Praveen Rosario is going to talk about the virtual power plant and its functionality and get into some architecture so, Praveen?

Praveen

Thanks Michel. So let's start by looking at the concept of the VVP concept itself. It's a good place to start and then we will look at the design and the architecture. So we know traditionally the power system as we know it, operates in such a way that generation assets are designed to dispatch and meet consumer demand on the fly. So it comes to the customer and at the end of the day they are never inconvenienced in any way and that's how it works. The moment you start integrating renewable like wind energy you have the task of using the combination of conventional generation resources which you can control and dispatch in a reasonable fashion, along with your more unpredictable resource like wind. You have to balance it to meet the same consumer demand without any inconvenience to the customer. So, there are obviously some balancing challenges with that. And traditionally we have other support and services that aid so you have your regulation and a bunch of other things that usually mitigate the variables associated with wind.

So, the first thought that came to mind was let's assist with some of the variability of wind by providing a wind following service using load shifting. So what that means is basically to track the wind generation by forecast or signal and use your consumer load to basically tie to that and that way relieve some of the stress on the conventional generation. We soon found out that this may not be the best way to achieve this for the

main reason that we could be introducing new system demand peaks and that could happen because you have a coinciding wind peak and then at the same time you have a system peak to begin with you are going to drive that peak even further if you have a wind following service and that is completely not deserved.

So we put our thinking caps on and then we decided let's look at it at a slightly different way, so we look at the same power balance equation and we take the wind generation component from the left hand side to the right hand side of the grid, and what that leaves us with is basically the demand on the system that has to be powered by generational now after taking all the grid can power. So, this new profile of load minus wind is basically what we decided to optimize to. In smoothing the leftover profile, we thereby reduce the strain on your conventional generation. Obviously that allows for the adoption of wind. So when we look at the components of that equation again, you have your conventional generational resources which are controllable and dispatchable, you have your consumer base, which is basically a portion of which through this program is partially controllable, and then you have your wind generation which is weather dependent, you take it as it comes with different forecast models and balance the system after the fact.

The primary proposed solution which we ended up adopting is basically use the load control to shift some of that demand around to reduce the variability of wind generation. We talk a little bit more and we get into the VPP and as we do this we develop a new tool to allow the system operator to more easily and efficiently balance the grid and definitely allow for the integration of more renewables. Go back a slide, to the power balance equation so we note that even if the wind generation turns out to be zero, the solution would still smooth out the profile whatever the profile winds up being, it reduces the stress of conventional generation. So the solution is such that if you take wind out of the equation, it still works, so it aids in assisting the system operator with its balance.

So this is an illustration of what we are talking about here. If you look at the load profile, again, think of this as the profile that is leftover to be serviced by your conventional generation resources after taking into account the wind power. You can notice before some significant noticeable peaks, so you would have your conventional generation trying to follow that. With our VPP solution we try to smooth that profile out and you look at the after case, is a lot smoother and suddenly the planning for system operator is going to be around this curve, as opposed to the before curve so that will make things a lot easier for them. So the idea is to even out the energy use and make the integration easier. The end solution that we have today, we have your system operator, talking to the virtual power plant, what it does is, it basically provides the load minus the forecast signal to the VPP we have the aggregate sitting on the right hand side of the VPP and these guys are contracted to provide the forecast and control of consumer loads. Usually we have them in groups we call load classes.

Basically what they do is they provide forecasts of what is available to the VPP, force shifting. Basically what happens downstream as a result of the shifting. Because we are dealing with pure energy storage at the end of the day, as Michel mentioned earlier looking at things like water heaters, pumping stations, HVAC systems, everything has an energy storage component to it. So it is truly balancing and shifting the energy through the course of a year, or whatever it be, the duration cycle for that particular place.

So as we see here, there is bi directional flow between the VPP and the components on both sides, we'll get a little more into the architecture now, a deeper look into what's under the hood, if you will. As you can see here, the VPP has components, there are two interfaces on either side talking to the aggregators and the systems operator, the interfaces are an open architect design, so we have project specifications so we are able to design what the interface requirements would be. The job of the aggregators is to conform to the specification. So they have to come though the table and conform to the project specification rather than bring in their proprietary solution. It was definitely a challenge for them in that regard. But what we were able to do was open the table to players, we were able to get different kinds of solutions integrated to the VPP and widening our base. It's the same idea on the right hand side of the system operator, so today we have the two VPP by the balancing area, we have one run by New Brunswick Power and the other one under Nova Scotia power and the idea is the same it's all run by power services that define that interface. The other important module in the VPP we have an executive module which basically orchestrates all the processes that need to happen that allow the function of the VPP and that's how the open source software.

Same thing with the data management subsystem which basically of the database that houses all the data for the VPP functioning. We have a dispatch optimization and control subsystem which basically runs all of the optimizations necessary to provide the VPP with its functionality and we also have a little logging and alerting subsystem. It is nothing fancy, but it provides some sort of logs to what happens on a fairly high resolution and we also have a graphical user interface that is made available to the VPP administrators and the system upgrader, so they have a lot of snapshot of what the VPP is doing, what it's load control plan is going forward, and it also provides control to the system operator.

So now we talk about the functions and the functions are basically assisting the system operators job, so that's the function we were talking about where we smooth out the profile, we call that load shape management and this is the almost, automatic cruise control mode of the VPP. To know that it's powered up, it basically, well, think of it as a VPP, it adjusts its output once every 15 minutes. As I said it's automatic it's a closed loop system and that's where it goes past your typical VR type product that's why we use the word dynamic, because it happens continually on its own, with no intervention.

The secondary function we have with the VPP is providing the equivalent of a 10-minute spinning reserve ancillary type service. This is a manually invoked function so it's at the discretion of the system operator and when it is requested, the capacity requested is made available within 10 minutes and sustained for a whole hour after the fact. This is a typical ancillary service; the idea is to call on it when you need it in terms of other support capacity on the grid. The primary function if you look at it in a graphical simulation , look at the original forecast shape is the blue solid line so that's basically your load minus your wind signal you can see it's got it's dips and peaks. The primary function of load smoothing would invert it into the smooth red dotted line, and this here is the information that is going back to the system operator. Ideally it was integrated back into the utility operations and they can look at it and yeah, VPP is going to do that and let's plan our conventional generation around this.

The secondary function, real time generation dispatch, this is where we have bi directional capacity that is published to the system operator, available for the ancillary dispatch. This example that is shown here is for a real time dispatch and now keep in mind since we are talking about virtual generation here, a generation up is equivalent to load shed and a generation down is equivalent to a load store. So as the graph clearly illustrates, once the RTGD is initiated the capacity requested is made available within ten minutes and you will have a load shed for a whole hour after that. Once this had elapsed the system returns back to its default mode of load shape management. Now I'll pass it back to Michel and talk a little bit more about customer participation.

Michel

Thank you Praveen. Yes, that was great. One of the things on the virtual power plant, it's a research of demonstration project, so it is not a fully commercialized product. There were opportunities when we designed this to actually take it from scratch, but again we worked it within the constraint of the product. We can't as an industry shape peace alone anymore. Build a system much more intelligently. We have to work in partnership now with our customers. There is no longer a one-way conversation and that is a whole new game and transformation for the utility industry.

I'm sure most would agree with that, so today we are at twelve hundred seventy customers and approximately sixteen megawatts and working our way to eighteen megawatts. The breakdown of that if we look at the end uses of the US residential of 170 devices one megawatt of connected mode. On the commercial side 15 customers, 40 total devices for a point to megawatts. Out of the UK 138 commercial customers 353 units that replace the electric base board heaters approximately one megawatt of connected load. People had to get used to a new form of heating now we've had Stefus heating [00.37.05 Inaudible] that were primarily used for valley killing and shaving, but this is a whole new dimension looking at renewable integration with these ETS units. The commercial thermal storage we've got 27 customers.

When we started working with the integrated companies with an open architect we would work with them individually and as we went out and even tested the market for this open ended platform everybody wanted us to use their platform because they all had a solution, a ready solution to virtually be a power plant and what was really important for us is to push back as we were doing this and say we've got and open ended solution and we need you to interface to it. I think there was a little give and take there, but eventually these companies all came to the table and provided that interface which when we start seeing utilities whether local distribution companies are vertically integrated utilities in the long term starting to feel these open platforms for our market settings an open platform to bring in different sources aggregations. The standards and the interoperability and activity of all of these products, standards will be very important because obviously the less adjusting that aggregation companies have to do to open standards is more cost effective to some of these solutions in the long-term, so there is more work to do their especially in the next generation demand response.

I think a lot of these companies were very good at demand response, but a dynamic demand response is a different conversation. Obviously some of them are doing it today, but not all also working more intimately with customers. For the most part customers they are very forth coming. Looking at a few photos here quickly electric face boards, the thermal storage, a new form of heat, a customer state value again in New Brunswick we have 1500 megawatts of electric heat at the peak of 130 megawatts someone can imagine the thermal storage units have the ability to come on off, but to also follow in more effectively. There is a huge advantage there and for customers they enjoy the heat that these things throw versus the base for heating.

They like the comfort levels better, so some of them actually wanted more of them, which was a good sign. Then again on a note like retrofit to a home it is much more costly on a new construction or potentially starting to penetrate the market place with this product in the long hall we have cold climate provides shift-able loads, so as we go forward we start to see policy. It is just potential for storage. Looking at the next and these are just a few photos. We have to keep the customers happy. We talked a little bit about this as a utility going from a commodity [00.44.16 Inaudible] going from a commodity suppler to energy service provider and the other side of the meter take a whole new level of trust. I think we as a utility have gained the trust of our customers for reliable cost effective safe electricity for the most part.

It sounds like it's a perfect world out there, but we've done a fairly good job at that as an industry. With this new world going on the other side of the meter, it's a good conversation for us and I don't know if all our customers see it within this space yet going beyond the meter, but it is very critical that we continue to build trust with our customers today going into tomorrow because we've got to go beyond the meter now and really

have a level of conversation with our customers to render a better overall into a system and they can really help us with that, but we have to help them within their lives, so they can help us. That will be new products and services. It will be an energy services company versus just a commodity electron sales company and it is really getting to know our segments, our customer's way more effectively than we do today. Building that partnership for the future. One thing you can think about, I think the whole utility is thinking about a renewable green theme and they are proud of it.

That has a huge value to a lot of our customers beyond just pricing signals and it is thinking about what do customers value and how do we as a utility make them and their day and help them and their cost of the corporate responses more commercial responsibility and be part of that. That has huge value, so again it is understanding what do customers value and how do we play into that going forward. It is like any other market. We've won a few awards with PowerShift Atlantic with Electric Association in 2012. Kay Association award in 2012 and recently Denver, but then again there is still a lot of work to do. Could be some type of rate scheme going forward, but again what will it take for us just going forward to get customers to engage in large numbers that's something that I think some of the results from this project will tell us.

What we did find that was interesting was that we had a really huge demand for these units and people were very forth coming to be part of this project and it surprised us in a way because we weren't sure what to expect, so if anything we had to turn people away. It is a good sign, but again I think it's a great question what's in it for me people are asking that and we continue to get that question down road what would be in it for me because there had to be something in it for you, so how do we get to that place, right?

Sean Great thank you Michel. Next question could you please clarify with the common system operator platform if you have two system operators accessing the same virtual power plant or if there were two virtual power plants and you just wanted to standardize the ISO interface.

Praveen Yes, so it's a very good question, so the way it works, it is a system level two. It goes by balancing area and that's one VPP balancing area, so it's one under the New Brunswick product and we have another one, so that is the way it works.

Sean Thank you Praveen and today what is the return on investment or is it negative since the project-

Michel I'll take that one. I think that it's early to tell. What I can say is some of these products obviously will have a greater return than others. What we're seeing here obviously these are two things: one is aggregation is evolving. Next generation aggregation is evolving and there's still work to

do on that front. I also believe that the cost of product that will be deployed that their over time will come down. Example, hot water heaters.

Sean Last question do you have any insight on how the CEA 2045 standard and other standards may influence integration?

Praveen We did look at the little bit of the existing standards that we thought may not be applicable at the start of the project, but then we soon discovered that for a bunch of reasons keeping in mind that this is a researching demonstration project and with other constraints and budget. We try to keep things fairly simple that's when we came with our own project specification which is very simple to this point. This is what is needed to get this thing up and running, but we soon understood that it might be overkill with what we are looking for here. As Michel mentioned earlier one of the things that this kind of work we do here is basically more research into what exist today in terms of those standards. How rare they may and may not be applicable what needs to change. I would think it would drive even knew standards out there in the industry.

Michel Quickly to add onto that I think one of the with this project is we do have 1270 loads customers out there waiting with multiple loads connected to a virtual power plant that's doing loads smoothing today. We are getting very little customers [00.58.31 Inaudible] I think there are all kinds of ways that we can think about some of these other expansions in the future and the degrees of sophistication no question this is not a commercial product, but it works. I think that is the key here. It works and this entirely possible, so as we set policy going forward and future research projects going forth demonstrations we have to look at what is the next steps. Then how do we submit some of this stuff a little more concrete more forward. There is some huge learning here from end to end in a vertically integrated utility set.

Sean Thanks again Michel and Praveen. We got a couple more questions coming, but unfortunately we don't have time to address those, so what I will do I will forward those through email to Praveen and Michel and they can get back to the attendees in their own time when they have a chance if that's alright.

Michel Yes, sounds good.

Sean Great, so before we close out I just like to ask the attendees to participate in a quick survey that we have it's just three short questions to evaluate how we did on the webinar and improve for future ones and the first question is the webinar content provided me with useful information and insight. Is the Webinar's presenters were effective and then the final question is overall the webinar met my expectations? Great thank you very much for answering our survey questions and on behalf of the Clean Energy Solutions Center I would like to again thank Jen, Michel, and Praveen for presenting in today's webinar and also for out attendees for

joining us and do invite everyone to check the Clean Energy Solution Center's training page if you'd like to download PDF copies of today's presentations and we will also be posting the webinar to that page as well.

In addition, this webinar will be posted to the Clean Energy Solutions Center YouTube page. That is the bottom link on this slide you're seeing right now and we have other webinars out there as well and also links to YouTube videos with Clean Energy policy leaders and so with that I'd just like to hope everyone has a great rest of your day and see you again in future Clean Energy Solution events and this concludes our webinar.