

The Present (March 23, 2015)

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Jennie Stephens: My name is Jennie Stephens, I am a faculty member here at the University of Vermont and I will be facilitating this second panel, in which we will move from considering the past to focusing on the current situation and understanding the current state of complex electric-energy relationships. My own research and teaching here at the University of Vermont focus on the renewable energy transition and societal responses to climate change. And obviously hydropower is a critical piece of the renewable energy transition. So it is both a pleasure and an honor to be part of the organizing committee for this very important conference.

As we struggle with the impacts of climate change and how fossil fuel reliance is resulting in climate instability, energy volatility and social and economic vulnerability, we are faced with the huge challenge of reducing fossil fuel dependency. Beyond the threats of climate change there are many other compelling reasons to reduce fossil fuel use, including enhancing geopolitical security, increasing energy independence and self reliance, improving public health, and creating more stable, predictable and resilient energy systems. But as we consider this transition away from fossil fuels toward renewable energy, it is clear that the different types of renewable energy are associated with different opportunities and different challenges. And it is also becoming clear that the very different scales within which renewable energy can be deployed, ranging from large scale utility scale renewables, versus small scale, local distributed renewable generation, also offer very different opportunities and challenges with regard to grid integration as well as local and community scale issues.

Many of us are acutely aware that the renewable energy transition is not a simple technical substitution from fossil fuels to renewables. This transition will ultimately require change in energy consumption including much more aggressive efficiency programs, energy conservation as well as social and cultural changes in our own expectations and assumptions for how we use and relate to energy. It is within this context that we turn now to hear about the current state of the electric-energy relationships including current contracts, policy initiatives as well as social and environmental concerns. We will start with Anne George, the Vice President for External Affairs and Corporate Communications in ISO New England. Then we will hear from John Kassel, a Vermonter, who has just recently left the Conservation Law

Foundation, where he was president from 2009 to 2014. We will then here from Jean-Thomas Bernard who is the professor at the university of Ottawa and the Université Laval, and then Stephen Molodetz, Vice President of Hydro-Québec, United States. So once again like the previous panel we have asked each speaker to provide brief remarks of eight minutes or less, and after we here from all four speakers we will open it up for an interactive session with all of you. And we welcome all of your questions comments and interactions. So lets start off, Anne, with your first presentation.

Anne George: Thank you Jennie, and good morning everyone. I wish I could give part of my presentation in English and part in French cause I love that, but unfortunately I don't speak any, I can say bonjour but that's about it. So good morning and is Louis still here cause she called me out a couple of times in her presentation and I wanted to do the same for her, but no no no she ran, she ran. But it is a pleasure to be up here in Vermont and to bring some, you know, sense of what's happening in the region and what we are dealing with on a regional level. We often come to Vermont, we manage, at ISO New England we manage the regional system and we work with all six of the New England states. So we often come up to Vermont to learn about what the policy goals are and what the initiatives are in Vermont so that we can understand what that would mean for the regional system. But - and a situation like this and a conversation like this with our neighbors in Québec is very important for the ISO New England and for the region to understand so I appreciate being here.

So lets get going. So ISO New England - I think most of you in the room are aware of whom we are. We are the independent system operator for the regional electricity grid. We are not a regulator; we are regulated by the Federal Energy Regulatory Commission. We are not policy makers, we do work as I mention with the policy makers in the six New England states and try to understand what goals the states have and we try and help facilitate that to the extent we can while we are doing our job of three important roles. Reliability is the core of what we are focused on, and we do this through three important tasks. One is to operate the system, day to day, in a reliable manor. The second important task we have is to manage and oversee the wholesale electricity markets, the buying and selling of electricity in the market and ensure that those markets remain competitive. And then finally we do look out over a ten year horizon to look at system needs and determine what is changing with the demand on the system, what is change with potential retirements and new resources coming on, and what the transmission and system need will be looking into the future.

So our transmission system, we've actually as a region done a lot of investment into ensuring that our transmission grid is reliable. There were decades of maybe lesser amounts of investment into the transmission system but over the past 15 years or so we have really made some of those investments, built projects. The utility companies that own the transmission system have built projects in each of the six New England states. ISO New England does not own any of this transmission but we

do have operating agreements and we operate the transmission system in a non-discriminatory manner. We have thirteen interconnections with our neighbors. So our interconnections with the neighboring systems are very important to the system. Last year as you can see here we had 16% of our regional energy needs were met from imports from those neighboring systems. And I have mentioned we have invested a lot, \$7 billion as a whole among the transmission projects in the region and we have another approximately \$4.5 billion planned in various stages in planning through the next several years. These are the ties to our neighbors, as you can see we have many ties to New York, that DC tie is through the Long Island Sound. We have two ties to Hydro-Québec and two ties to New Brunswick. So we do work closely with those regions and understanding what's happening in those regions, as well as sharing information about what's happening in New England so that they understand our system needs and system characteristics.

So I wanted to make a point to what Louis said early and actually John on our panel here was commenting the same, Louis from her vantage point she said you know a lot of the discussion that happened in the 80s, they are not much different from the discussions happening today. And so Louis I wasn't around in the 80s, well in the energy world, I was around but in the energy world I wasn't around, but in my time frame in the energy world we are amidst of a lot of change and so, you know, it is interesting to see the different perspectives.

But from what is happening in the system right now in New England, we have moved from our generation, our fuel of choice has moved from oil and coal to natural gas. We still have a decent amount of nuclear on the system and renewables are starting to increase, but the growth in the actual capacity, in the steel in the ground, the plants we have in new England have been dominated by natural gas generation. And if you look at what plants are producing electrical energy for the region, you see here that natural gas dominates. We had 44% of electrical energy last year was produced by our natural gas generation resources. Nuclear makes up a big chunk of that as well. And these are 2014 numbers, we have Vermont Yankee on the system on 2014 it closed down at the end of last year and so we will see what those numbers are for 2015. But as you can see the energy production is coming primarily from the natural gas fleet. And you see here the oil and coal. Oil has dropped down to produce only 1% of our energy over the year and coal at 5%. During the winter months, however, those two resources, two fuel sources are producing a larger chunk of our electrical energy during the winter months because of the constraints on the natural gas pipeline system coming into the region. We have had seen difficulties from the natural gas generation sector accessing the natural gas fuel to produce energy. So what is taking up the slack there is the oil and coal.

And so this shift predominately natural gas for generation purposes, we can see the impact of that in our wholesale electricity prices. You can see here that those high spikes are driven in the winter months by the cost of natural gas. Because we have so much natural gas on the system that usually sets the price for wholesale

electricity and our energy markets. And it really tracks that price and in the past several winter you see these price spikes. Last winter, the one we are not currently in, even though it is still technically spring, we are in winter - the last one, we really saw some dramatic price spikes, natural gas prices in New England were the highest of any place in the world, last winter in New England. And so we are seeing that drive the costs in the wholesale electricity market, they weren't as dramatic this winter, even with the terrible winter we've had. And that's driven primarily because we saw lower prices because of the lower oil prices, but because we had a decent amount of liquified natural gas come into the region, and that alleviated some of the demands and what we saw in the pipeline system, driving up the price.

This transformation in our fleet has also resulted in some good news in our missions' profile. We have seen over the last 15 years or so emissions go down in the region. They have gone down substantially because of that shift away from the dirtier fossil fuels of coal and oil. However, in the past couple of winters we have seen that level off and actually start to increase a bit because we have now gone back to using some of that oil and coal that had almost gone out of our system but we've had to go back to that. And actually it's interesting - coal and oil has, or oil in particular, has been more economic than natural gas so it has run in our markets based on an economic reason not necessarily for reliability purposes. So you see this start to have a little uptick, these are up to 2013, so it doesn't capture 2014 or the winter we are currently in. But we expect to see that trend continue while we are in this situation where we are relying more and more on coal and oil than we had in the past.

So renewables, you know this is something of great interest, great interest to us but great interest to the policy makers in the region. The drive for renewable energy is something that will continue and we see that right now they don't make up a huge amount of our energy capacity in the region but it is growing, it is growing at a fairly good rate. Wind in particular; wind is something that is probably the area where you will see the most growth in renewable resources. Wind, we currently have about 800 MW on the system, but there is a lot of desire to build wind in the region. A lot of it is in northern Maine and it is challenged because the transmission system in northern Maine is not robust enough to interconnect all of this wind. But we see 4,000 MW are interested in being developed into the region. Doesn't necessarily mean it will all get developed, but a good chunk of that will likely get developed, especially if we can figure out collectively, the transmission needs and transmission system up there. Solar, solar I know Vermont has a big push to do solar, other states Massachusetts in particular, Connecticut they are doing their own solar programs and so we see solar coming on strong. Most of it is behind the meter at the distribution level, we do not see this in our operations, but we are tracking it because we understand now it is getting to a place where it's large enough that it can have an impact in terms of what our operators are dealing with on a day to day basis. So these actually are the 2013 numbers. We recently put out a draft forecast for solar PV and it increased the numbers, we think that we currently have 900 MW of solar out there in the region and we expect over 2,000 MW of solar voltaics will

be developed by 2023. So that that is an area of growth, and then I know that there was some discussion in the first panel about energy efficiency. The states are spending approximately a billion dollars a year on energy efficiency. It is a big resource for the states and for managing the system, managing the growth in demand. And as you can see here we have approximately 1300 megawatts of energy efficiency and that is projected to grow to over 3,000 MW on the region.

And so finally I just want to wrap up with transmission again, back to transmission and this is transmission that is not necessarily, we haven't labeled it needed for reliability, it is, these are various projects that are being talked about as ways to bring additional clean energy into the region. They range from bringing hydro down from Québec, hydro down from New Brunswick, wind projects in Maine down to load centers in New England. But there is a lot of discussion out there, and there has been a lot of discussion about many of these projects for years. There is a little more interest and little more discussion right now because we have seen the states, the New England states start talking about doing something collectively on this. The three southern New England states have issued request for proposals on transmission projects to bring clean energy down. So there is a lot of discussion going on. From ISO New England's standpoint we don't necessarily do much with these projects other than to study them to ensure that they can safely and reliably interconnect into the regional system. We - these aren't project that will kind of go through our reliability system planning process, they won't have the same cost allocation among the New England states as some of the reliability projects I spoke about earlier. So these are projects that we are obviously involved in and are looking at and interested to see where they go. But it is hard to know which of these projects will materialize and it is up to these developers and I know that we will have some further discussion on that. So I think I'll stop there and I look forward to the Q and A.

John Kassel: Good morning. Thank you Dave and Richard and Jennie for organizing the conference. I particularly, as a Vermonter and Burlington resident, I would like to add my welcome to our friends and guests from North of the boarder. It has been a pleasure to spend some time with you and I for one have found the conversation from the first session very enlightening, and an opportunity to really understand, dig a little bit deeper than the very superficial level of understanding then I could, that I had, into some of the dynamics North of the boarder that are obviously very important. We have similar dynamics South of the boarder as you may understand and I suspect that we will get into those as we go on for the day, during the day.

I am John Kassel I am in the program as the former President of the Conversation Law Foundation, which is certainly true. Something I am very proud of, I want to issue a clear disclaimer though that I am here in my individual capacity today and not speaking officially on behalf of Conservation Law Foundation. I would say that my excellent former colleague Sandy Lavine, who is with Conservation Law Foundation, now is here in the audience and can speak on behalf of the organization if any questions are put in its direction. I would say CLF has a unique position, with respect to the issues that are under discussion here in that we are active - CLF is

active in all of the six New England states, and is very active in all of the energy issues in particular, and especially those that relate to system planning and the way that fine organizations like ISO New England and all of the partners involved in keeping the lights on and supplying our energy needs do.

So Anne and I did just compare notes about Louise's provocative point earlier this morning, which I'm glad she made, which she said, you know everything is the same, it is all the same. Certain things are definitely the same, and I have great respect for my friend Louise McCarren. She is right, we still have inadequate rate structures, she's right about a lot of those things. I tend to think though that things are not the same at all as they were in the 80s. I think we're - it's a bit like an Esher print, if you know what I mean, where you got fish coming across the page on one side and you got birds on the other side and somewhere in the middle they start to blend. I think we are kind of in the middle right now. And if you are used to thinking of the fish side, we're still a school of fish, right? I think, actually, we don't know if we are going to end up being birds or something else. There is an enormous amount of change in the works right now, Anne very helpfully referred to some of it. A whole lot of it has to do with the changing mix, with our dramatic increase in reliance on natural gas as an electrical generating source, not to mention a source of energy for other purposes in New England over the last 20 years. But from my perspective and here I think I will reflect generally the environmental communities point of view, we have a firm understanding now that we didn't have five, ten years ago that we have to dramatically reduce carbon emissions in the first part of this century in order to avert or at least minimize massive destruction and suffering around the world. It is a bit of a downer statement but I believe it is true, and when you really dwell on the gravity of the challenge, the enormity of the challenge and the gravity of the consequences if we don't rise to it, you start - whether that Esher print starts to look different on the other side of the page.

I put up a very simple slide that comes from the Energy Information Agency, which shows the percent of CO₂ emissions by sector of the economy, this is 2011 data for the New England states. And it shows as you can see, this is percent by state obviously the populations are very different, but note that the electrical power segment is not the leading cause or source of carbon emissions in any of the New England states. And collectively if you put it all together is it actually like something like a third. In transportation and space heating and all of our other energy uses, we emit a lot more carbon through what we do. But the science tells us, and it is worth pausing about this. The science tells us there is really no debate about it anymore, that we need to reduce our carbon emissions by 80% below 1990 levels, which is roughly where we are right now, by 2050. That is economy wide, that's not just the electric sector right, so we can clean up the electric sector, make it a whole lot less carbon emmitive and not do anything about transportation or space heating and all the fossil fuels that at least in this country we are heavily reliant on for those needs, and we're toast; we are not even going to come close to meeting that imperative. In fact, we need to shift a large portion, perhaps almost all of the fossil fuel entered

from the carbon emissions from transportation, to a non-carbon source, and that is, very likely, to be highly electric.

So imagine that in the next 35 years we have to not only decarbonize our existing electric load, but we are probably going to have to increase our electric load. A note on that is, efficiency is a huge untapped resource. There is a great deal we can do - there is a lot that we can do to make more of what we have now from electricity. But think of the magnitude of this, look at those numbers. Vehicle miles traveled continue to rise, fuel efficiency in cars is increasing, that's a good thing, but in Vermont its 56.7% of our carbon emission is from transportation. And we don't have a land use structure, as much as we like to believe that we do in this state for example, that is really going to support a lot of walking and pedestrian, walking and transit. This is a massive challenge for us. If we start to shift space heating, commercial and industrial use and the transportation sector to the electric sector, it just gives you a sense of the nature of the challenge we have. And that challenge - just for context, this is also similar to the national picture.

So this is the challenge that we face, and I wanted to spend a minute or two on it because it's really important that we frame all of the discussions about the evolution of our energy system, our sources and where we are going to get them from and what we are going to do with them, from this perspective. I would also note not to dwell on the gloom and doom, but it is also likely at the middle of this century, New England will be in a position to absorb significantly more population. There will be parts of the world that are not going to be habitable in the way in which they are habitable now by mid-century. Imagine hundreds of millions of people who live in low-lying areas of South Asia. Imagine hundreds of millions of people who live in hot dry places that are going to get hotter and dryer and are going to be very difficult to live in. New England is going to have water, we are going to have a lot of opportunity as a result, and I would submit, here speaking entirely personally that we will have a moral obligation to accept population that we are not even thinking about right now. So in New England not only do we have to shift load to the electric side and decarbonize the electric side, we may actually increase in population significantly by the middle of the century, if not by the end of the century.

This is really a massive challenge and it is a large planning exercise that, frankly, nobody is really doing. And I say that with great respect for my colleagues at ISO New England. They plan the system, they manage the system, but they are not the czars of energy in New England, nobody is. As I think Louise mentioned on the first panel, you know, we make energy policy in New England by governors they do this, they do that, they will collaborate when they want to, and I have great respect for all of our governors, but she's right. They are somewhat opportunistic, they'll do what they need to do, they will collaborate together when it suits their needs, and they won't when it doesn't. We've seen that in the current climate, which includes six governors, two of which are elected every two years, there is a challenge right away in two states that are important for transmission purposes, to note. And energy policy is cobbled together in some way by the states and the New England and the

Québec and the Canadian provinces, Québec and the maritime provinces, when it's convenient and when it's advantageous. And I do believe that there are many people involved in making this policy that are thinking quite logically and strategically and some are great leaders. We have seen some great leadership from the Commonwealth of Massachusetts, great to have former commission David Cash here, Dr. David Cash excuse me as your bio points out. But it is difficult to herd these cats.

So that's the challenge that I think we face and which leads me to conclude that it is not everything is the same 20 year ago, in 1980, 1990. In fact we are at a very significant inflection point. Now is a time of enormous change, much of what is happening is what Anne described. We've - the low natural gas prices have obviously had a lot of effects. One of those is that it has been it has enabled us to shut down a lot of our coal plants, which needed to go. We've gotten off oil, which we used to burn to make electricity, we've seen more renewables come on, we are starting to see the emergence of the smart grid. If any one has questions about that, our moderator Jennie Stephens will respond to them, she is an expert on that. Efficiency investments in the states and the provinces that are doing them are really baring enormous amount of fruit and we are seeing what we can do with those. And particularly in Vermont, as Deputy Commissioner Springer said earlier, we are seeing a great deal of distributive generation. And that I would submit - which is small production, largely renewables, in some parts of the region fossil fuel based, but strategically based within the grid in order to support the grid in a way that can maximize the benefit from what we - from the grid, from our investment in the grid. The future is clearly in renewables, and I would submit all the New England states believe in a robust renewable energy sector within each of the states.

Last night some of the panelists were treated kindly by the University to dinner and one of our hosts put out the provocative question, so well it is really a question of, our we going to get transmission lines from the north or gas pipelines from the south? Which is kind of an interesting way to frame this, for those of you who are northern New England focused I know there has been a significant natural gas discussion in Vermont lately. You may not know that in southern New England it is not just a discussion about natural gas, it is an onslaught. The pressure to expand the interstate natural gas pipeline into southern New England is intense, and there have been proposals to do it in a very big way. In the same way that I think many in northern New England, particularly our friends from New Hampshire, and I know there is at least one audience member from New Hampshire, feel a bit like there has been an onslaught of electrical transmission lines coming, or proposals coming from New England. My perspective on this is that either one will do, but only if done very carefully. Some expansion of natural gas used wisely, is a very good thing to alleviate near-term crunches both on the electrical generation side and on the heating side in New England. Just like some importation of cleaner power than we normally get with in our system in New England from Canada, from some place in Canada is a very good idea. Each of those power sources coming in have to, first and foremost, take offline dirtier power, they have to replace dirtier stuff. And secondly, and this is

an equally high priority, frankly, they have to support the development of renewable sources within New England.

Power generators, power transmitters be it natural gas or electricity, know how to craft arrangements to make that work. And I would submit that the power transmitters, electricity from the North or gas from the South or the West, that will thrive and will win in the race to figure out whose going to be part of that picture on the other side, you know on the other side of the Esher print, are those who are savvy about that, who understand that New England states want renewable power. New England states by and large believe in the climate science, and New England states will not negotiate for power that throws them off of the future that they are starting to see evolve in their states, which is one of widespread distributive renewable generation, of significant and ongoing and sustained investments in efficiency, which are after all our best investments. There is plenty of room for good investments in efficiency going forward. And importantly and I note this particularly, and in particular light of the experience that been had in New Hampshire lately, that recognizes the importance of equitably sharing the burdens and the benefits of major investments in the system.

I found very interesting the conversation in the last panel about the North-South dynamics within Québec. And obviously the First Nations in Québec have a unique, fundamentally different position than any other residents of North America, quite frankly, in their region. There is a little bit of a North-South dynamic in New England that I think it's worth surfacing here. The load is in the South right that is where people need power, eastern Massachusetts, Connecticut, Rhode Island. The transmission corridors tend to be across the North, Maine, New Hampshire, Vermont, perhaps northern New York. There is great potential I believe for undersea transmission cables, which resolve some of those issues. But exporters of power from Canada, who treat the northern New England states as nothing more than a transmission corridor, and I am being somewhat flippant and I don't mean to be offensive to anybody but lets be clear about it, if that's the attitude that's perceived by the states that are being asked to accept those projects, those projects in my opinion will have a far harder time getting to market and will by virtue of projecting that approach or taking that approach will make it very difficult to - for all the parties to engage in the kind of collaborative discussion about the terms on which the power is going to be used in New England. So I would strongly suggest that whether it is a gas pipeline from anywhere, or a transmission power line from anywhere, there ought to be significant attention paid to what's in it for the communities that are going to host that power line, and those are conversations that have to be had way up front. And I think there are some projects in the works today that are doing, that have learned form some of that experience and are doing a very good job with it.

Finally let me just note that, back to agree with our colleague Louise, one thing that really hasn't changed is that nobody plans this. And I offer this for everybody in the room but particularly the students. Could I just note, how many students are in the

room today? Terrific. Are any of you interested in political science, or government, or the policy side of things, that's great. You've got a career ahead of you, let me just say. We are - just as we don't have a global energy policy, and we don't have a national energy policy, we don't have a regional energy policy. And we don't have a governance system that is designed or even suited, quite frankly, to developing that policy. ISO New England does a terrific job keeping all of the masters that it has to observe, and it's independent I understand that, but it is a very difficult balancing act to deal with six different governors who are turning over, you've got utility companies, you've got FERC, the Federal Energy Regulatory Commission every now and then saying, you know you got to do what you do to respect the needs of the states in the region, you've got environmental groups like many, you know, pushing their agendas. It's tough, it is very tough. This is sausage making, sadly. With a lot of money at stake and very high stakes if we don't do it right. It isn't to say we have an unreliable system, we don't. We have a highly reliable system and that's one thing that I think has been accepted as a given. But I would submit to you that in this respect it is 1980 again, it is 1990 again. And just as many companies that have, that are private companies that carry out public interest activities, or activities that have a public good element in them have begun to open up their governance to greater involvement by those who represent the public. I believe that that's going to be necessary if we are going to do this right, that is efficiently, with a good outcome at the regional scale. So for those students that are interested in this, I encourage you to dive in and I would be happy to talk to you at the break. So thank you very much.

Jean-Thomas Bernard: I am very pleased to be here, I like the place, nice place, yeah? So I am going - I am a low-tech person; students do this all the time for me so I never had to learn, it works. Here is the outline you know for my presentation, so basically in Québec we are in the process now of updating the energy policy. There is a wide set of questions that are being addressed. Now you see on the screen the main topics of interest, so let me point out what challenge the Quebecers are facing in this respect.

First energy efficiency, energy efficiency has been mentioned quite a few times this morning. Now we know that the purpose of energy efficiency programs is to increase the ratio of energy service relative to energy use. So basically we want to do more with less. Now a program of this nature has been implemented since the Oil Crisis of the 70s. And it has given rise to what economist call the energy efficiency gap. By this we mean, the user doesn't realize as much energy saving as standard cost benefit analysis will indicate. So that's what we call the energy efficiency gap. And, you know, various factors have been pointed out to explain this gap. One is the so-called rebound effect. You know, energy services become cheaper so people use more of it. Also there is the free-rider problem, you know that, some of this that we have observed would have taken place anyway, so the outcome of the program is less than expected. And there are the unmeasured costs of implementing this program, for the people that are subjected to this program, and for the people that delivered that. So these programs are not as efficient as we would like. Now this problem is particularly severe in Québec, because Québec has one of the lowest

electricity rates in North America if not the world. So basically standard cost-benefit analysis give rise to less worthwhile program. So if we want to realize roughly the same thing as the neighbor, we have to put in a larger effort. Now unless the government of Québec is willing to move the rate up, the challenge would be on the table for the next years to come. So I am not going to say more about this because there is a very strong feeling of Quebecers about, you know, rate increase. So here we will be talking of a much larger magnitude of what we observe year to year.

Now, let me move to renewable energy. The first question I want to address is, you know, is the question of the development at this stage. Does Québec need more electricity now? We are in a surplus position, so we don't need more electricity now. Before analyzing what type of renewable energy source we need to develop, we should also consider the need itself. So right now there is no immediate need for new source of electricity because there is a debate about how big is the surplus, but it is there, and it is fairly big. Big enough for the government to have implemented a surplus policy with respect to getting over this energy surplus. Now, so basically when we consider renewable energy, at this stage, specifically hydro project, we should be concerned with respect to the market, you know, for this electricity.

We must recall, you know, as I have mentioned, we have real cheap rates in Québec. It has a definite impact and this based on costs. There has never been any subsidy from Hydro-Québec to its utility, so over time, Hydro-Québec must have done a reasonable job so costs are low. Now we have developed hydropower site through an increase order of costs, and that was the thing to do. And the manifestation of this is that we are moving further and further North; cheap accessible sites they have developed first, and now we are way North. Now since, you know, we have moved North, costs are moving up too. And right now, what we call the marginal costs, the cost of new development, is much higher then the average. You know let us think the average is something like three cents per kW hr. New power sites like, La Romaine, there is a bit of dispute, but it is definitely way above that. According to my own calculation it is like eight cents per kW hr. And the next hydropower site will be more expensive, you know we are moving up.

So the question we have to consider, as a Quebecer, is there a market now? Permanently? Or within the neighboring region is there a market for electricity at eight cents per kW-hr? And nobody is showing up at the boarder and say look, I would like to sign a contract for 20 to 25 years at that price. Nobody. So obviously aluminum plants don't want electricity at eight cents per kW hr, you know their kind of ceiling is something like three cents, you know, we don't want to pay more then three cents. So there is a huge gap there. And right now, you know, there is no urgency, either in Québec or in the neighboring region. Ontario has a surplus too. New England I think is in no rush to have additional supply. We may find out kind of strategy creation to change who makes of electricity source. But right now there is no urgency. So that's a fundamental question, you know, other things will stay on the table and maybe as time goes on it will be time to address, but at this stage I

don't think it is, you know, that the market is presenting a good opportunity for long-term development of a renewable power source at this high cost.

Now, Québec has one valuable asset that won't stay there for a long time, although right now there is a lot of work that is going on to find a way to store electricity because of this incoming intermittent power. So there is a need for that even in a slow growing system. Now Québec has a huge asset, that has been mentioned this morning, it is the capacity to store water. You know, it's there and it will stay there for years. So when the times come to develop further renewable power, which will be more probably intermittent either for the sun or the wind, I think that this will still be very valuable.

Now we have not talked much about oil. In that respect Québec is no different from the other regions, neighboring region. There is a concern about the long-term impact of fossil fuel use; obviously the context in Québec is different. Here I would definitely would like to point out the difference between the consumption and production. For consumption our concern is very much like everybody else and also, you know, there are a lot of talks about using more electricity. Now electricity comes back to my point I have already made. You know, new electricity in Québec is not cheap. So if we want to move that way, the cheap electricity is already in used. Do we want to increase rates so people will stop you know heating their house with electricity? That's a big challenge. So gift wrapping new hydro, developing social for electricity to support a shift from fossil use in transportation to electricity use, you know, the challenge will not be very different relative [to] the other areas around us.

Now we have also once in a while a debate about oil production in Québec. We are not a producer no, or a tiny tiny little one. So here you know, I just want to stress, as an economist, we should make a difference between consumption and production. A lot of people would like to slow down the use of oil, but curbing production is not the way, curbing consumption is. When the then question comes up if we should develop some oil, I think it should be looked at from a profitable basis for the whole society. But whether we would produce it or not, we will still be using it. Thank you. I failed to mention that we are one year ahead with respect to the formulation of a new policy in Québec, we should have waited to see what would be the outcome of the Paris meeting on climate change at the international level.

Stephen Molodetz: I was not taking any chances on the electronics; nothing will kill your credibility sooner than not being able to work the slide projector. Good afternoon, my name is Stephen Molodetz. I am the vice president of business development of HQUS, we are a subsidiary of Hydro-Québec and we are based in Hartford, Connecticut. We sort of feel like we have a resource that unlike any other generating resource can address a wide range of reliability and public policy challenges in the region. But that resource isn't without its challenges to get more into the region; Anne talked about a little of the regional challenges, I am going to talk a little bit more about the challenges of transmission so we can bring more of that product in.

HQ as we like to call it is among the largest electricity utilities in Canada. We are one of the largest hydropower producers in the world. The company generates, transmits and distributes electricity in Québec. Essentially, we are the utility in Québec. So here in Vermont for the most part it is Green Mountain Power, in the province of Québec, it is Hydro-Québec. We also sell electricity on the wholesale markets; we do that here in Vermont and New England and predominately that function is handled out of our Hartford office. Finally the company's sole shareholder is the province of Québec.

This is a map of our grid that you've probably seen numerous times, and probably numerous times already today. 44,000 MW of renewable energy. Just to give you a point of comparison, in all of New England there is roughly 32,000 MW of capacity. The dots across the province show our major hydro facilities. You see way over on the right is a project you've heard talked about a couple of times today, La Romaine, four stations. By 2020 we will be bringing on 1,550 MW of clean renewable hydropower. I think when you look at this map, and unfortunately it is not great at showing New England in the proximity to Québec, but I think here in New England we need to think about that proximity as a geographic advantage for the region, right? We've got a tremendous hydropower resource just to our North and an energy partner interested in extending and expanding the long-term energy relationships that we already have. We also have one of the largest transmission systems in the world, 21,000 miles of high voltage transmission lines. There are two interconnection as you have heard earlier today, with New England. One that's about a 1,800 MW interconnection into western Mass, and the other is about 225 MW here in Vermont. We are also looking at a new interconnection, the project is called Northern Pass. We are partnering with our partners at Eversource Energy, formally Northeast Utilities, where we will construct, own and operate a 47 mile line on the Québec side of the boarder, and they will own and operate an 187 mile line from the southern - from the Québec-New Hampshire border into southern New Hampshire and we would be the energy supplier on that line. It's a 1,200 MW high voltage DC line.

Hydro-Québec is connected to four major New England markets: New York, New England, Ontario and the Maritimes. We like to think our markets as complementary to our export markets. By that we mean we peak in the winter, driven mainly by electric heating load, as you've heard people talk about today, and our export markets for the most part are summer peaking, and driven by summer air conditioning load. So that's a great synergy in terms of exports to the region. By exporting to these four markets, based on economics, we make each of those markets more efficient. From one year to the next we export about 30 terawatt-hours a year; of that 30 terawatt-hours about half ends up typically in the New England market. Just to give you, again, a sense of magnitude, 30 terawatt-hours is about 25% of the total consumption in the New England region. Again of those 30 terawatt hours, 1.2 terawatt hours is currently under long-term contract to the Vermont utilities. Hydro-Québec signed its first long-term agreement with Vermont

utilities in the late 80s. In 2010, HQUS signed a second agreement, again 225 megawatts for a long-term supply of clean, renewable hydropower. I think Vermonters, I am not sure if they realize it or not, benefited greatly from that contract in these past several winters, where the rest of New England retail consumers were seeing roughly 30% rate increases. In part because of this contract and its sort of price smoothing and dampening formulas, [Vermonters] didn't see anywhere near those types of impacts.

As you can see from this graph, you know, the contracts showing down below, that roughly two terawatt-hours, that little green horizontal bar on the bottom, there is plenty of room for other New England states and utilities to consider long-term contracts with Hydro-Québec. Including winter deliveries, there tends to be a misperception that because Hydro-Québec is winter peaking and New England is currently experiencing some winter challenges, that Hydro-Québec can't help during that period, simply isn't true. During the peak periods in our coldest spell this past January we were exporting roughly 1,700 MW an hour. This is one of the major benefits that Hydro-Québec provides to New England. At the time the greenhouse gas emissions and carbon footprints are on everyone's agenda, Hydro-Québec generated in Québec is one of the lowest carbon emitting sources of energy, pretty much equal to wind on the basis of a life-cycle analysis. Over the last five years Hydro-Québec's exports to its neighboring systems have avoided 62 million tons of carbon dioxide, and that is equal to the annual emissions of 16 million vehicles.

Anne touched on this briefly, and you have heard others mentioned it as well, but I am going to dive in a little bit deeper. We feel our delivery into the region help with a number of New England's energy challenges and I want to touch on those briefly. The first challenge is reliability, as Anne talked about the increase in natural gas fired generation having gone from about 15% in 2000 to roughly 44% this past year, which by itself isn't necessarily a bad thing, and it has some environmental benefits, generally replacing dirtier fuel. The problem is the pipeline system to bring gas to those generators hasn't kept pace. It is a pipeline system that was really built for residential and commercial heating load. So in the winter months when the pipeline is being used to meet that peak demand, there is very little natural gas left for natural gas fired generation. And the little gas that is left is going to be very high priced, and very high priced gas leads to very high priced electric markets. I think the ISO estimate from this past winter is that wholesale energy costs are \$3 billion higher than the previous winter, predominantly because of this issue. So the increased reliance on natural gas has both reliability and consumer cost issues. The final challenge is the regions desire to transition to a clean energy sources. I think most of us are probable aware of the aggressive RPS targets in the region, but the states have also pursued legislation and program to reduce GHG emissions significantly.

I like to think there is a hydro opportunity for the region, and let me tell you what I mean by that. Essentially, we think the hydro opportunity is achieving multiple

market fundamental and public policy benefits with a single resource. There are a couple points on the table I would just like to touch on. First of all, new supply. The ISO has estimated that 8,300 MW of non-gas generation is at risk to retire by 2020. And these retirements have already begun. 4,100 MW in the 2013 to 14 timeframe including Vermont Yankee. We think of new hydro resources as being poised of helping fill that gap. The second is cost. Incremental energy supply from a low operating source like hydro will have downward pressure on wholesale prices. Economics 101, new supply same demand, prices are going to go down. Finally, flexibility. Hydro especially when it is combined with High Voltage DC technology is an extremely dispatchable, almost instantaneous technology. This means it can balance various variable resources and help meet peak load demands.

So if hydropower offers all these great solutions, what's the issue of getting more into the region? Why haven't we been able to accomplish that? Probably the first issue that comes to mind is the funding model for the new transmission projects that are needed to deliver additional hydropower. Given the economics of such projects and the current market conditions, a regional funding or beneficiary-pays model is needed. Although it is probably a surprise to many of the people in the room this isn't a tremendously new idea. This is in fact how the vast majority of all of the transmission in the region is developed. The \$7 billion that's been built recently worth of new transmission in New England, and I think the \$4.1 billion that is projected that Anne mentioned, all that will be regionally funded. The second thing is siting, and we have talked about this several times today. A major challenge for any energy infrastructure project, whether it is electricity, whether its transmission, gas pipelines, wind farms, communities are reluctant to site energy infrastructure projects in their backyards. We completely understand and respect the siting challenge. I think the big issue here is to balance costs, the increased costs of siting challenges, with the siting process itself. Third, there is no market mechanism to recognize the value that hydropower brings to the region, right? The various attributes that hydropower has that maybe aren't applicable to other generating resources, right? RPS for the most part doesn't qualify hydro; there isn't a fuel diversity bonus for hydro projects. So somehow a market mechanism to recognize these additional benefits that hydro power brings is going to need to come forward if we are going to get more of the product into the market. Finally, to meet the ambitious goals that New England has set for itself, we need to recognize that all types of renewable energy are needed, whether is it domestic, international, whether it is wind, whether it is solar, whether it is hydro, we are going to need them all. So a little bit less of the infighting of my renewable is better then your renewable we think will go a long way.

Fortunately it is not all gloom and doom. Despite the issues facing increased access to hydropower into the region; there are several initiatives under way that recognize the need for action and solutions. For the past several years, NESCO, the New England States Committee on Electricity has been studying the issue, and has essentially concluded that new energy infrastructure is needed. Specifically the six new England governors have recognized that new gas pipeline, transmission

capacity, and new electric transmission to low carbon resources is going to be needed if the region is going to remain competitive. Increased hydropower will lower the demand for natural gas from the power sector and in turn can stabilize prices. Just last month, Connecticut, Massachusetts and Rhode Island issued a draft three-state RFP to procure clean energy and transmission. And along with this Massachusetts is considering legislation that would allow the state to contract for significant quantities of additional hydropower. Along with our partners at Eversource we are working to consider how our Northern Pass project can fit into competitive solicitation. Given the advanced state of the permitting and the efforts that are being made to solve the siting issues, along with all the various studies that have been done, we are confident that the project is well poised to take advantage of this.

So in conclusion Hydro Québec is the largest Hydropower producer in North America and one of the largest in the world. We operate a world-class generation and transmission system and we feel we can be a solution provider to the challenges facing the New England region. So thank you very much for your time and I look forward to the questions.

Jennie Stephens: Ok, well thank you to all four of our panelists. We had very interesting, distinct but complementary perspectives, I think, that we just heard. So what I would like to do is to open it up. I think our speakers did go over the eight minute limit. So we have about 15 minutes before lunch, so I would like to open it up directly and to questions. And I'd ask that people stand and identify yourself and address, if you have a specific question to a specific panelist. And to enable maximum participation, let's all try to be brief in our responses and in the questions. So let's open it up. We have students who have microphones and there are hands up already so if people could - OK, here in the front middle. Here we go, thank you and please introduce yourself.

Tom McGrath: Tom McGrath, Rice Memorial High School. According to the program this panel was intended to address economic, social and environmental concerns. They were touched upon, briefly, I think. But I think maybe Mr. Kassel you've addressed the economic, environmental, and social issues to the most extent. What I see is a glaring omission from this morning's panel to this one is the Aboriginal concerns, right? And I see it didn't even appear in the presentation from Hydro-Québec, so as the sole representative here, and the spokesperson for Hydro-Québec, is it a done deal, the sort of negotiations or concerns of Aboriginal peoples and how these projects impact them or are these concerns still ongoing as far as you're concerned?

Stephen Molodetz: Well I think it is at this point in the program where I need to emphasize the US portion of my title. I represent Hydro-Québec US and I don't mean to dodge the question, because I think it is a great question and is very important. But I think what I would say is that Hydro-Québec has pioneered relations and negotiations with Aboriginal communities. And there is a process in Québec, to get

sites - to get projects sited, approved, and built. It is not the Wild West up there where they are running roughshod over Native populations with no laws, no regulations. There's Canadian and there's Provincial laws and siting processes. And what we do is participate in those processes and no project goes forward unless three criterion are met from the company. Which is, it's got to be profitable by a standard of our projection of export and domestic markets; it's got to be environmentally acceptable; and it needs to be accepted by the local community. And that third one is important, and I don't think that during any project, and probably when this building was built, my guess is that there were folks who opposed it. Even when the siting process was concluded and it got approved there were probably still some folks who didn't want this building built. Yet, here it is. So I don't mean to be flip - what I mean to say is that I don't think there is ever 100% acceptance of any project, and certainly an infrastructure project of the magnitude that Hydro-Québec build is much more impactful and so deserves a bigger hearing than a building like this, but it is never going to be a 100%. So I think the best answer I can give you is that absolutely it is ongoing. Absolutely, Hydro-Québec takes it very seriously and the projects don't move forward unless they are accepted by the local community through that process, not through 100% acceptance of every member of the community.

Jennie Stephens: Thank you very much for that question, do any of the other panelists want to address that, or should we move on? There are lots of other questions too, so, OK, how about it the back here?

Francis Lacombe: Francis Lacombe with Technostrobe in Montréal. Mr. Kassel spoke about the importance of transportation and the importance of decarbonization of transportation. I was wondering if Mr. Bernard has actually examined this notion that the competing price for electricity can actually be a \$60 tank of gas that can go 60 kilometers as opposed to a three cent KW hour for the aluminum industry. Is there an opportunity there when we are decarbonizing transportation for a greater price for electricity?

Jean-Thomas Bernard: Quick comment. I have written extensively on the kind of indirect subsidy that the Government of Québec is providing to the aluminum industry to lower the price. This is a practice that I don't favor. Now right now we have favorable circumstances so this makes me worry. Because you know we have surplus and when you have surplus you can - you are looking for the best alternative you have on the table and obviously the aluminum industry is looking at that too. So hopefully, you know, the government will resist because this will imply further development of hydro resources in Québec. And as I mention that this will not cover the price that the aluminum industry wants to pay. Now, with respect to electrification of the transportation sector, here you know, you know this is a global issue, obviously we make and draw in that direction when a large number of people buy, willingly, an electric car, or, you know, a car that doesn't emit green house gas. Québec may have some resources, but again we must not forget that additional electricity in Québec is almost as expensive as what we observe in the neighboring

region. The cheap electricity in Québec is the one that we sell to ourselves at a really low price. So until we get over that I don't think that we will make huge headway towards electrification of transportation sector.

John Kassel: If I just may add, we put a price on carbon this all happens by the market. We just, you tell me when that happen, but that gets to the governance question.

Amy Seidl: Amy Seidl from the Rubenstein School and Environmental Studies here at UVM. I really appreciated the emphasis that all the panelists brought to there presentations on carbon mitigation and climate change. And I saw it everywhere, whether we are talking renewables or targets. But I didn't here anybody talk about climate adaptation and how good an entirely centralized transmission work in an era of ecological uncertainty. Although we did here from Anne about the rise of renewables and the possibility of solar working from a decentralized position. I didn't hear from others about what kind of resilience are we developing to increasing uncertainty and variability in climate that then puts our electricity systems at risk. So I would just like to hear comments from any of the panelists on that point.

Anne George: Well I'll just add, we are seeing a lot of movement to more microgrids, more of this distributed fanned out energy grid type system. So we are seeing the transformation happen and think that's only going to grow in the future. How that is managed is going to be tricky. It adds to the complexity of managing what's on the regional grid and what's off the regional grid and how do you watch what's going and do you manage then. So it's going to add to the complexity but we definitely see that movement happening. And I think as more and more customers get involved in there energy usage and energy choice, it's going to make the whole system much more complex, and you are going to need resources available to manage that variability. So the quick start, available, flexible resources are going to be even more important in the future.

John Kassel: If I could just add, it's a great question. It's a great opportunity for us, it's just another part of this system that is changing and it's an expensive part of the system. Vermont hasn't - we don't have coastline; we haven't had an ocean here in 10 to 12 thousand years I don't think. But if you have been to the coast of New England, you know there are huge, lots of components of the electricity energy system that are very much at risk. They have to be - we have to plan carefully to build them, rebuild them in a way that is resilient. I think ISO New England and its planning function is doing a great job with the utilities that are doing a great job of watching for this. But it's just another example of how we are about to reinvest in our energy system in New England whether we like it or not. So it is an opportunity to do it in an intentional way that will promote a resilient system going forward.

Jennie Stephens: Sorry, in the back.

Guest: University of Montréal, Environment Sustainable Development graduate program. I would like to commend the lady that asked the question about adaptability. I think we have an absolute obligation to do that, and I think there is confusion even if we believe that the climate is governed by anthropologically bound carbon emissions. The implicit idea that if we reduce that we are not going to have Sandy in New York, or Katrina in New Orleans, is a terrible problem. I think issue resilience is a major stake for humanity, and we need to pay attention to that, just as much attention as carbon. And now Monsieur Bernard I would like to ask a question from a strictly rational or rationalistic economic perspective. Understanding the question of energy density and the impacts of renewables etc. etc. Take Québec as an example, where we have a surplus but we also have a drive that seems to be there, that has a legitimate political presence in society about promoting wind and so on. If you look at this from the perspective of optimal use of electricity, and the limits on energy storage and the costs of batteries, and etc. etc. etc. What would you conclude by way of sum up, in terms of what economic rationality teaches us.

Jean-Thomas Bernard: As I've told, the capacity to store basically electricity is quite huge in Québec. So since - it is still the position of the government to develop further wind power in Québec. Although right now, you know, I think this is too fast because we don't need the electricity. This capacity will stay there. It was not developed for that purpose basically but now it plays that role and I think it will stay very valuable for a long time. How it can be improved this capacity, I don't know, but I think we should pay close attention to that.

Jennie Stephens: I think we have time for one more question but I also just wanted to return to this comment about resiliency and climate adaptation. I think one thing that we need to keep in mind is this balance and complementarity between decentralized systems, energy systems, where individuals, households and communities have the power to have more influence and engagement with their energy system, versus large scale, utility scale, centralized systems. And I think that's a real tension and obviously we need both as we move forward and both are moving forward but I think the resiliency questions are particularly relevant when we think about enhancing the decentralized systems. Similar to what Anne was mentioning too. I think we have time for one more question before lunch, and I want to make sure I've looked at different parts of the room, and I think we have a student in the back here that I would like to welcome. Please introduce yourself.

Brendan Clune: Thank you, my name is Brendan Clune. I am a junior at UVM. And I just was curious, this is mainly a question for Mr. Molodetz and Ms. George but anybody in the panel can answer. Concerning the interconnection between the renewable distributors in Québec like Hydro-Québec and like between them and major distributors down mainly in the southern part of New England, National Grid, NSTAR, etc. Has that relationship been generally constructive and positive or has it been more, say, with feet dragging and resistance with these networks that

traditionally rely on less renewable resources, and how do you see that relationship proceeding in the future?

Stephen Molodetz: Great question - if I understand it correctly, I think the relationships, for the most part, the N-Grid's, the NSTAR's, the Eversource's, they are not themselves heavily involved in renewable energy sales, right? They are more buyers of renewable energy power, as their various state RPS programs require them to. As it relates to the transmission project we are partnering with or other transmission opportunities, I think, to be honest with you, they all frankly look at it as an opportunity to make a positive impact for New England in terms of all the benefits I talked about. We have had conversations with probably every one of the existing utilities in New England about the idea of, what is the best way to get more Hydro-Québec hydropower into the region? And the reason that they are interested in two fold: one is kind of shareholder related, and that is, sure, they are interested in developing a transmission line that they will earn a return on. The other I think is a little more altruistic and is in the interest of their customers, because they see the benefits we do. They see the challenge we see. Which is the over reliance on natural gas, and what are we going to do about that. If not Hydro-Québec hydropower as a new baseload resource enabled by a new transmission line, what is the new baseload source of power is going to be in New England. Is it going to be more gas? Well that tends to exacerbate the pipeline problem we are talking about. Is it another nuke? I find it hard to believe, I mean my bracket is busted in the NCAA but I think I can figure this one out. There is not going to be another nuke built in New England, right? Coal and oil have the environmental emission problems we talked about so we are down to other, Hydro-Québec hydropower and other renewables. The other renewables tend to be less available in just terms of the sheer quantity and they tend to be intermittent, whether it's solar and requiring the sun, or whether it is wind and it requiring the wind to blow, whether it's wind power. So I think they saw the hydro opportunity kind of as I outlined it of sort as benefit to the region and their customers and sort of pursued it from the perspective. That was a really long-winded way of saying, it has all been great.

Anne George: And I would just add, you know I think it has been interesting watching the states develop their renewable energy portfolios. When they first started discussing them in the late or mid 90s time frame, it was seen as, let's focus on the small renewables, the new renewables, the things that can be build either in my state or in my region. So there was a reluctance to look at large hydro. There still is, there are remnants of that, but I think as Steve mentioned as the desires on the starts have grown to do more renewables, to meet climate goals, they are looking at what are the scale of resources that they are going to need, and that is when hydro comes into play, large hydro comes into play. And so I think that is changing the nature of the relationships among Hydro-Québec and New England states.

Jennie Stephens: Great, well thank you all, and before - hopefully we can continue these conversations at lunch. There is a program during the lunch break, we have

student awards [to] be presented and a speaker, and then we will reconvene in this room at 2:30. So thank you all for your participation, and lets thank our speakers one more time.