An Interview with
MARK ALHSTROM

Conducted by Marta Monti
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Windlogics, St. Paul, Ramsey County, Minnesota

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Interviewer: Today is July 9, 2015. My name is Marta Monti, and I will be interviewing Mark Alhstrom. I've been able to look at your website and find out what sorts of work is done at WindLogics, and I was wondering if we could just start with you telling me a little bit about how you got involved and how you first heard about the CapX projects.

Interviewee: Okay, well WindLogics has been helping people build wind and all solar projects for, well, 13 years or so. We were acquired by NextEra Energy in 2006. NextEra is one of the very large independent power producers in this part of the country. Even before then, though, I was involved with Wind on the Wires which is a local group that really looks at transmission development for renewables.

Interviewer: Right.

Interviewee: I'd say probably most of my knowledge about the CapX projects has been through ongoing involvement with Wind on the Wires.

Interviewer: What sorts of work do you do with Wind on the Wires?

Interviewee: We've been members of Wind on the Wires both at the WindLogics level and at the NextEra level for many years.

I've also helped them out from time to time on technical analysis around some of the testimony, or cooperating with them on being on a Technical Review Committee for the recent Minnesota Renewable Energy and Integration Study.

We tend to be a little techie around here. We're not so much the power engineer folks that you might see at other places, but we're a lot of the meteorology and math and software looking at how you optimize good projects and offer that energy into the market, into the MISO market, for example, and how you operate those plants really well, both for wind and for solar.

Interviewer: Yeah, yeah. Tell me about some of the people who are your clients, who come to you and ask for technical assistance with their studies.

Interviewee: Well, prior to acquisition by NextEra, and really prior to 2006, we had many clients throughout the Midwest and continue to have a lot of those people after we were acquired, but more and more now, NextEra has been keeping us very busy.

They're the largest developer in the country, so we primarily now work on the development and optimization of their wind and solar projects.

We're also more broadly looking at the industry and how we can improve the overall market for renewables, and make sure it's integrated efficiently into the MISO market and other regions of the country as well.

Interviewer: I was speaking with Michael Noble at Fresh Energy a few weeks ago, and he was telling me a story about how Matt Schuerger really pushed the engineers at MISO to look differently at their models and the way they forecast, and how they integrated wind into that.

Interviewee: Yeah.

Interviewer: I was wondering if you had any thoughts on this, and how your work—is it similar?

Interviewee: Very complementary to what Matt does. Matt spent a long time leading engineer and the power, especially in the transmission sector around the Midwest, and in fact I—well, actually the first time I met Matt was going way back to the Xcel Integration Study for Wind back in 2003—I believe it was. I think he was the Project Manager for that—for the State Department of Commerce. Since then, he's coordinated most of the large wind and solar integration and transmission studies for the Minnesota Region. He also served as the consultant to Wind on the Wires when they were going through a lot of their involvement, so everything was tied together very nicely through Matt. He's done a great job at running projects, to bring everybody to the table and to really figure out optimal solutions for this.

Interviewer: Yeah. How do you interact with MISO?

Interviewee: Well, we have numerous projects here that are offered in to MISO, either directly by us or by the off-takers of our power purchase agreements for wind plants primarily here so far. We've been involved in the stakeholder process in terms of how they are viewing and integrating wind, and we particularly have been involved in what they've done with what they call the Dispatchable Intermittent Resource Tariff, which really tries to get wind fully into the market, much like any other type of generation, and have it in the real-time market, every five-minute dispatch. We're seeing

that that also encourages people to offer wind at the Day-Ahead Market so wind becomes a fully integrated market participant..

By getting the best—especially the best very short-term forecasts that are within about ten minutes of each five-minute period in the real-time market, wind can have a pretty good forecast when you do it very close to real-time.

Then if you dispatch it reasonably, wind can really be part of the five-minute dispatch in a way that is still fair to the physics of weather and wind and wind forecasting capabilities.

Interviewer: Mm-hmm. Tell me about the details. How did you work with MISO on getting that tariff? Is it through attending meetings and providing input?

Interviewee: Yeah, and certainly I would attend some, but we have other people at NextEra that have attended many of the stakeholder meetings at MISO around this. We have submitted testimony in response to proposals, gone to technical meetings as a stakeholder in a process.

Generally I think we've been very supportive of what MISO has done with trying to really get wind into the market system as a full participant rather than just a must-take resource.

Interviewer: When did MISO shift to using this five-minute and real-time forecasting?

Interviewee: Question now, I'm trying to think. I think it was about three years ago or so, if I recall, when most of this took place. If you check the tariff, there was a date on when it was switched over. Most of it's been over the last three years, maybe four years, if you go in back to the stakeholder discussions from what I can recall right.

Interviewer: Mm-hmm. How has that changed the way things work for you in the past few years since it's been implemented? Does it?

Interviewee: Well, people have been more interested in wind forecast, and also looking at the uncertainty around forecasts. With the real-time market and MISO now, there's pros and cons to how do you do this. Because what you see with wind plants and the solar plants is that an individual plant has a lot of variability.

There's going to be changes in the wind, and but a lot of that variability goes away when you aggregate it over a larger region. If you put that into the whole MISO footprint up here in the west of

the MISO region, by aggregating into that footprint, you get a lot of smoothing. Now you could argue, then, that renewables should be put in as a portfolio like that, because a lot of the system impact on MISO or any system operator is more on the aggregate. There is, of course, some local transmission impact as well, which is why MISO and others like to use individual plants, all offering into the market separately.

Then having it dispatch for each plant. Then there's a deadband around that dispatch point that you're expected to stay within. Otherwise, you could be subject to some penalties.

Interviewer: Right.

Interviewee: It's tricky. If that deadband is sufficiently wide, where you can forecast with a good forecast—then that can work. It may not be an apples-to-apples comparison. It's like a gas plant or coal plant that we're really trying to make wind and solar fit into that mold. Now, there can be cases where it's difficult to stay within that, just because of the implicit nature of the wind itself. It's not like we're trying to intentionally deviate. You can only get the energy that's there from the wind at the moment or from the sun.

It's really important to get a forecast that's going to be as accurate as possible going into that, if you're expected to follow that dispatch set point.

With wind it works, as I said, pretty well, as long as you get to within ten minutes or so of the start of that five-minute period. Because if you look at the forecast air curve a day ahead, the forecast is pretty hot here. As you get close to the real time, it goes down toward zero.

Because wind doesn't really change a lot over the next couple of minutes. If you're standing out there, you feel the gustiness in your face, right? That's the low-level turbulence. If you actually smooth that over a large wind turbine or across multiple wind turbines and a wind power plant, that low-level turbulence pretty much goes away, and you're looking at more gradual changes.

Wind works pretty well if you can lock in your schedule just shortly before when you're going to use it.As you move out, it goes up pretty—the error rate goes up pretty rapidly.

A difference between trying to do the five-minute dispatch in MISO with a ten-minute-ahead forecast versus an hour-ahead

forecast is really night and day. It's probably five, six times higher error rate trying to do it hour-ahead rather than five-minute ahead.

We were actually fairly encouraged by MISO's approach to the Dispatchable Intermittent Resource Tariff, because it at least recognized this forecast ability aspect of wind and allowed you to get a forecast that most of the time would allow you to stay within the deadband.

Interviewer: Did MISO go far enough with the tariff?

Interviewee: Well, I pointed out to them personally that it's still not quite apples-to-apples, in terms of how they look at this point-by-point and plant-by-plant scheduling and dispatch. I think that there are cases where wind plants are penalized just because the wind changes and they fall outside of the deadband.

If you looked at the actual system impact, if you aggregated even just a few plants and a quarter of the State or something, you could argue that the system itself didn't really feel much of that impact. You don't want to penalize people for things that are outside of their control, right? Like Scotty says on *Star Trek*, "I can't disobey the laws of physics here," right?

There's only so much I can do given the nature of the fuel source.

Interviewer: Right.

Interviewee: You want all the rules to really reflect the physical reality of the fuel and the technology that's being used to generate the power at each of these plants.

I think the MISO approach with the DIR is a good compromise. I am concerned that with solar power, the forecasting error trend is a little bit different. It's not yet clear that the forecast error decreases as much as wind's does as you get down toward real time.

Interviewer: Mm-hmm.

Interviewee: Right? If you're in a partly cloudy day you're still gonna have fairly random clouds.

Interviewer: Depends on what time you're looking up.

Interviewee: They can be abrupt. On the other hand, the data I've seen shows that if you aggregate several solar plants together, that variability is actually diminished even more rapidly than it is with wind, right.

This could still be an issue. If they try to apply the current rules for wind to solar we're not yet totally sure that that's something that would be viewed as fair.

We're all for being totally into the market, being a total market participant. That only makes sense that—in the old days, wind was a must-take, right. You just were a price-taker in a real-time market. They wanted to take you, because you are a clean and low-cost fuel basically.

It's tough to think that you can get to high levels of renewables without having those renewables actually participate in the market, because the market is also about how you optimize the entire fleet of generators that you're going to dispatch and commit farther in advance.

Interviewer: Yeah.

Interviewee: That day-ahead commitment type process, that real-time dispatch process, are both very important optimization steps, and so you have to somehow get the best forecast of the renewables into those optimization processes.

We think the right way to do that is through market rules. The trick is, how do you make them really fair to the implicit characteristics of the fuel source and the generator technologies?

We've had a lot of time to figure this out for conventional plants, like coal and gas and nuclear and hydro and so forth. We've been doing this for decades, and the rules that are in place really were written to reflect the characteristics of those fuel sources. For example, you have to have a day-ahead unit commitment because you can't just start a coal plant in an hour, right?

Interviewer: Right.

Interviewee: The coal plant has to know a day ahead, do you need me or not? So a lot of these market rules really reflect already the implicit characteristics of the technologies and the fuels that are in the conventional fleet.

Now to have renewables come in with a whole different set of

characteristics is what makes it interesting on the policy side, right?

Interviewer: Mm-hmm, mm-hmm.

Interviewee: Because we don't wanna throw the baby out with the bath water in terms of changing rules and how we operate, because we still need everything to work together. If you only forced wind to schedule day-ahead or even hour-ahead as traditionally been done really wouldn't work very well for wind or for solar.

Interviewer: Right.

Interviewee: It works okay for a gas plant, because you have a very good idea how much you can produce in that two-hour period coming up, or whatever. You have a much—your forecast is a little bit easier, right?

Interviewer: Yeah, yeah. One person I spoke with used the analogy of changing out all the parts on a plane while you're up in the air.

Interviewee: That's really what we're doing.

Interviewer: That's what essentially we're trying to do, and yeah, you're right. You're a man, of course, you hit the nail on the head. This shift from using the conventional rules, even the way we transmit the electrons has changed, so our policies in the way we approach it has to change. I think now, hopefully solar, hopefully we've learned enough with wind now and realized that these changes need to happen in order to optimize solar. I mean, even MISO's a little over a decade old.

Interviewer: They're still learning as well.

Interviewee: Absolutely right. That’s a great point is that these market systems themselves here in North America are pretty new, and still tweaking things. I think wind has been the great catalyst for both the markets and for your vertically integrated utilities to really go back in and re-question how are we doing things? What tools do we have? Given today's computing and data collection systems and so forth, can we make it a lot better?

Interviewer: Mm-hmm.

Interviewee: It's become a catalyst for developing the whole next generation, not only of the rules, but of the software and the control room—the

marketing software itself. Here in MISO they're not too worried about solar so far, because it's still relatively small in the size of their system. Other parts of the country are struggling with it more. To some extent solar is—in some ways solar is easier, because you know when the sun is gonna rise and set. In other ways, solar is more difficult because all of the energy really happens primarily at one part of the day.

Right. The combination of wind and solar is actually pretty powerful one, though, because if you combine those together, you get additional smoothing.

It tends to be complementary—

Interviewer: Right.

Interviewee: - because overall, just average numbers, the wind tends to be a little stronger at night and early morning than it is during the afternoon, and obviously it's reverse with solar.

A lot of the integration studies I found very interesting results that the combination of wind and solar is better than trying to do it with either one of them alone.

Interviewer: Mm-hmm, no makes you think about a lot of things.

Interviewee: Oh yeah. Diversity is good, though.

Interviewer: Yeah, yeah.

Interviewee: Just like in your investment account, you don't want all your eggs in one basket.

Interviewer: Yeah, but it's how soon can we realize this and make wind and solar co-gen a reality before we—'cause we can't stay stagnant at the moment we're not gonna put all our wind projects on halt until solar catches up.

Interviewee: No.

Interviewer: Is there a way to build with the possibility to expand.

Interviewee: They don't have to be both simultaneously. They don't have to be at the same locations. I mean, I'm not talking about putting wind and solar at the same plant. I'm saying overall for the system. For myself—

Interviewer: Just using them—

Interviewee: Yeah. If you look at it at the system level, and you actually—and that's an important point is you're never going to balance wind at an individual plant. I mean there's no value in turning a wind plant into a flat block of power. When you really think about it, it's probably more expensive to integrate a flat block of power into the power system than it is at least one that has the ability to move.

Interviewer: Mm-hmm.

Interviewee: Right? Because you gotta match load. Load is not flat either.

Interviewer: Right.

Interviewee: There's constantly variability going on here. We're used to that. We get a slightly different variability from wind and solar, and it's not like it's a totally new problem that we haven't been dealing with for decades, with load variability as well. The right way to look at it is I don't have to firm up any one of those generators. I have to look at the overall aggregate, the combined variability of wind, solar, and load, and other generator variability.

That's what I really have to affirm. I think what we're going to see is that you get a lot of solar like you're seeing in California. You do change that combination of load and solar generation pattern and that load pattern.

I think we're going to see a lot of more activity from loads themselves to participate in the market or to take advantage of the change in power prices over the day. There's no reason we can't do that, with today's computing and technology where a lot of that can be automated.

Or you'll see companies that come into existence to aggregate a lot of the residences, so that you can use them as demand response. You get car chargers for electric cars in there.

Interviewer: Mm-hmm, mm-hmm.

Interviewee: You get car chargers in there to charge at the right time. You can use that to smooth out a lot of that aggregate variability.

Interviewer: Yeah, right.

Interviewee: It's an exciting time, and no one knows exactly how it's going to go. It's gonna vary a lot from one part of the country to another.

There's multiple ways of solving this problem, but certainly Minnesota is at the forefront of a lot of the work on this.

Interviewer: Yeah, yeah. Let's take a step back, in a sense, and talk about the Renewable Energy Standard.

Interviewee: Sure.

Interviewer: How that has changed. I mean, we're talking about these advancements, in getting wind, and what was it like for you when the Renewable Energy Standard was passed in Minnesota?

Interviewee: Well, the renewable energy standard has been really a major driver of wind energy, not just in Minnesota but by creating the market for the entire region or country here. Minnesota has been definitely a leader in that for decades. For us, it actually helped us get our company really started in the wind space, back around 2002, 2003, the earlier days. 'Cause we were a small start-up company with all this meteorology and modeling expertise—

Interviewer: Mm-hmm.

Interviewee: - looking for a way to apply that, and a lot of our early customers were people doing community wind projects here in Minnesota, or people doing development on the Buffalo Ridge.

We would help them model new projects and come up with better ways of building the wind plants.

Interviewer: Mm-hmm.

Interviewee: Convincing the bankers that the wind energy was really there, and what the uncertainty would be around it. Then helping people optimize the site and that lay-out of the turbines on that site taking all the science of the wind into account.

Interviewer: Mm-hmm.

Interviewee: For us, it really helped get WindLogics off the ground, and lead to our acquisition by one of the major players in 2006. Now we're a major employer here in Minnesota.

In fact, when I started with the WindLogics, we were 17 people, and today we're about 90 just in the WindLogics group. We're part of a, of course, a much larger energy company now that's got thousands of people.

Interviewer: Yeah.

Interviewee: They do a lot of their investment up here in Minnesota and in the Midwest as well.

Interviewer: Mm-hmm, mm-hmm. One of the key things that you need with these wind farms is transmission lines to connect it to the grid.

Interviewee: Right.

Interviewer: How have these new lines, and how have, not just CapX but also in the region and in the MISO footprint, how have these new lines impacted and been benefitting. I know it's been beneficial, but if you could speak to that a little bit.

Interviewee: Well, the fundamentals of developing a wind project or a solar project is you need the resource the wind. You need a customer who wants to buy the power.

Interviewer: Mm-hmm.

Interviewee: You need a way to get the power from that project to the customer, right?

Interviewer: Mm-hmm.

Interviewee: Unless you can get the energy across to them, they're not going to buy it. Even if you don't have an off-take and want to do it merchant, I mean, you're not gonna build a plant where you're gonna be curtailed so much that you can't make money on the project.

You have to pay the bills. Curtailments of wind projects has been a major concern everywhere in the country, and Minnesota's no exception. By building additional transmission, you're really creating much larger market for additional renewable energy projects. You're able to actually get that to the customers that want it, and by reducing curtailment you can allow the customers to get it at a lower price.

It's a win-win for everybody by having deliverability of your product. It's no different from any other manufacturing plant or anything.

You can make all the widgets you want. If you can't get 'em to customers, doesn't do you any good, right? What are you gonna do?

Interviewer: Some of the folks from CapX like to say that when the lines are energized, it's immediately helping with curtailment.

Interviewee: Yeah.

Interviewer: Do you agree?

Interviewee: Oh yeah, yeah.

Interviewer: I mean, I see it having—the lines are beneficial on a lot of fronts, but two main ones for curtailment is that, one, it immediately helps with what is already existing.

Interviewee: It does.

Interviewer: Then, two, it allows more generation sources.

Interviewee: The CapX lines have been designed looking at the wind resource regions and where they expect to see both existing projects that are already commissioned and new projects to be built.

Interviewer: Mm-hmm.

Interviewee: It definitely immediately resolves a lot of the congestion problems and allows a lot more of that clean energy to get to market. Then it does create business development for new projects to come in and also take place there that—those projects would not happen without the transmission being there in the first place.

Interviewer: Mm-hmm, mm-hmm. While I've been talking to some planners through Xcel and GRE, when I was talking about how they decided where the lines will go and what the routes will be, one thing that really lacked was that knowledge of where—I mean, anyone can look—I mean, not anyone, but you can look at a map and you can see where it's windy and the certain states and the certain regions that are windy, but you have to talk with developers and people who build these projects to actually find out—

Interviewee: Correct.

Interviewer: - where they're going. I'm wondering if you, maybe through wires—I know all these groups talked, and I'm wondering if you had any input with these planners, or if they—did you ever hear about them contacting—

Interviewee: I think we did, at least indirectly. We were the company that actually developed the Minnesota wind map for the Department of Commerce.

Interviewer: Oh, I'm very familiar with that wind map.

Interviewee: I think that some of the modeling done at WindLogic certainly contributed, at least indirectly, to where they were looking at the best wind resource regions.

We also produced other maps as part of our participation in some of the integration studies, for Xcel and the State of Minnesota 2006. There's been a lot of data that's come out of those that produced wind maps to show where the resource is.

You have to do an overlay of where the wind resource, and then where can we build the transmission or do the upgrades that are necessary?

It takes a dual-pronged approach to really try to do this as well as you can.

Interviewer: Yeah, yeah. Dual-pronged and iterative in the sense that—

Interviewee: Very much so, yeah.

Interviewer: - definitely like to keep going back and do what you can.

Interviewee: I mean, you also need to have landowners who want wind.

Interviewer: Mm-hmm.

Interviewee: Some of it is driven by where is there good public support for doing projects, as well as the resource and the transmission.

Interviewer: Mm-hmm.

Interviewee: It all has to fit together.

Interviewer: Yeah.

Interviewee: You do tend to often see clumps of wind projects, and you could argue it would be better to spread them out further. They tend to clump up I think for a couple of reasons, just speaking as from my own experience. I mean, one is that there aren't that many areas where you have good wind resource and good transmission access.

The other is that once wind plants get into a region, peoples tend to see the upside of them and see that they're actually not something to be feared.

They're actually good for the economy, good for the community and well-accepted. It's easier to do additional projects in that county, for example.

Interviewer: Sure.

Interviewee: We do see these clumps like on the Buffalo Ridge and other areas here that—and obvious targets for the CapX lines.

Interviewer: Mm-hmm, mm-hmm. It most certainly is. Who are some of these—who are some of the players that you work with? I know you do some work with AWEA. Is that correct?

Interviewee: Yeah. Yeah, we've been active with AWEA in terms of what they do with the AWEA Transmission Committee, for example.

I'm also very personally active with the Utility and Variable Generation Integration Group and Xcel, and most of the other Minnesota utilities are active members of that group as well.

That’s a group that really looks at the bigger picture about—a utility-driven organization looking at shared experiences, what can we learn from all the studies? How can we learn from each other about how this is working?

We found that to be useful, and I think a lot of the Minnesota utilities have found that to be very useful as well. More at the engineering level, I-triple-E—Institute of Electrical and Electronics Engineers, I believe it is. I just call it I-triple-E now. I-triple-E has been active on some of the standards, and it has committees as part of their power and engineering—I'm sorry, power and energy group of I-triple-E. They've been looking at wind and solar integration issues and transmission issues, of

course. Who else has been—well, you had mentioned Michael Noble and Clean Energy—Fresh Energy, rather.

Interviewer: Right, right.

Interviewee: I think here in Minnesota it is that combination of groups like Fresh Energy and Wind on the Wires, and national groups like Utility Variable Generation Integration Group, AWEA regional activities of AWEA. They cooperate with Wind on the Wires very closely.

Interviewer: Yes.

Interviewee: It's that combination of both smart advocacy groups who know that you actually have to build things like CapX lines in order to make things work. The utility is really doing a great job, I think, of studying the issues. Their participation on the recent Minnesota Integration Study was outstanding. We looked not just at the economics of doing this, but looked very closely at the reliability aspects as well, and found that if you do good engineering like we've always done in the past, and continue to do, you can continue to grow and—you do need to figure out how to do the right upgrades to transmission lines and sub-stations and so forth. Just as you would with any conventional generating—

Interviewer: Mm-hmm.

Interviewee: - right? I think utilities are getting much more comfortable with how does wind work, for example, and how would we do the optimal upgrades for that?

Interviewer: Yeah.

Interviewee: It's been a real combination of great cooperation, I think, between the utilities and the entire region. The transmission planners and the advocacy groups.

Interviewer: Yeah, yeah. There definitely is a confluence of collaboration which is always interesting, yeah, to think about what had to be done to make that work. There's a lot of trust that's implicit in going forward at times. That's not to say that it's always so—

Interviewee: Yeah, I'm not saying that that level of cooperation and collaboration doesn't also exist other places in the country.

Interviewer: Of course.

Interviewee: It doesn't always exist.

Here in Minnesota, I think we do have just a history of at least listening to each other, and let's talk about the real issues on the table and see how we can move the ball forward.

Everybody has to give and take with that and cooperate in it. I'm glad to be part of Minnesota and to see that in action. The CapX is a wonderful example of that, but how do you get a lot of people with different interests at the table and actually get something done?

Interviewer: Yeah, yeah. Back to transmission, is there enough? Do you see more lines in the future? What do you—

Interviewee: Yeah, well—

Interviewer: It's hard to say no, but—

Interviewee: - love the lines. Transmission lines are good.

Interviewer: Yeah, but so we're not quite done with the build-out?

Interviewee: Well, we could do a lot more, and certainly, as part of the clean power plan and other—whether it happens with the EPA right now or later, we're going to be moving toward lower carbon sources of generation for our power system. I think we'll see that wind energy, and more and more solar energy are becoming the real low-cost ways of doing that. Both for Minnesota and in terms of helping out neighboring states with exports of power from our good resources in parts of the State.

I think that'll be an ongoing interest and motivation for more transmission lines, because the combination of getting the good wind and solar resource and getting it where we need it can really produce very good economics for our rate payers.

We can get some very low-cost renewables these days, and the price continues to get better as the equipment continues to get better and better.

Interviewer: Right.

Interviewee: I think wind and solar will be an ongoing growth area, so that does mean that we might be very interested in more transmission, and

try to develop that back when we need to get it around to the country.

Interviewer: Yeah. When RPS was passed in Minnesota, and as they were passed around the region and the country, MISO saw a huge influx of generation requests in the queue, overwhelmingly so. Do you see something like that happening again if and when 111(d) goes through?

Interviewee: Well, I think what we've seen is quite a lot of growing up, I think on the renewable side as well. We've seen a lot of consolidation where renewable energy is not just the new kid anymore, it's becoming a mainstream player.

Interviewer: Mm-hmm.

Interviewee: A lot of what you'll see, I believe, my projection is that with 111(d) or other drivers for cleaner energy, it'll be customer-driven. You have to come up with a strategy for the State or region, depending on how we do it here that makes sense.

Interviewer: Right.

Interviewee: Then you look at the engineering and the possible options and the portfolio you wanna have. I don't think that it would be overwhelming influx in the inter-connection queue.

Certainly, all of the smart developers are keeping their options open and doing the work on locating good sites and what might make sense.

I think we're a little bit past the wild-west days where we were seeing lots of small projects and small developers. They still have a role, but more and more it's being done more hand-in-glove with the utility customers.

Interviewer: Mm-hmm, mm-hmm. I know you work for larger farms, but I'm wondering if you have any opinions on distributed generation and how that fits into things, and how it fits into what you do.

Interviewee: Well I think, again, I think diversity is good. We're seeing a lot of distributed solar, like the community solar concept. I personally think that's a very attractive approach. I also think there'll be a mix of utility-scale projects and distributed projects. Utility-scale solar, for example, has an economy of scale that's always going to give you a lower price per megawatt hour.

Distributed also has advantages, both personally and politically, and to some extent from having it be more distributed where it can at least offset some of the local upgrades that might otherwise have to be done.

I think we're gonna see both, and I think a range of solutions is almost always the best approach here. Solar will be a key part here in Minnesota, as well. I think that will be both residential, commercial and industrial. Utility-scale and the community solar concept, I think, will be pretty popular one here, from what we're seeing so far in Minnesota.

Interviewer: Yeah. We're getting towards the end. I'm wondering what sorts of challenges do you see coming up in the future for wind and wind integration? Or what are you experiencing now and would like to see changed?

Interviewee: Wow. Let me think. Well, MISO is actually doing a very good job in my personal view, so we're not seeing some of the concerns that we are in other parts of the country to be honest. There are advantages of having a large and diverse footprint like we have here in the Midwest with MISO.

They're taking a nice and deliberate approach to this. There's not an urgent problem. They have the resources and the market design to integrate a lot of renewables without any real perceived challenge. Certainly no challenge to reliability issues and things like that.

Interviewer: Right.

Interviewee: We are very carefully looking at reliability issues. In fact I'm, along with people from MISO like Mike McMullen, from MISO - we're both on a NERC Committee, this Essential Reliability Services Task Force right now. We're looking exactly at that, of how do you make sure that we get reliability services from wind and solar plants? Because, for example, if we retire some of the coal plants and replace that with more wind and solar, we still have to have a reliable system.

That's been a concern. People will say, "Well, how do I know that that's going to happen?" There's groups like NERC and others that are there to make sure that you will be taken care of.

We're still trying to—we're trying to work through right now exactly how you should do that. Do you need those set of reliability services from all plants just some of the time, or do we create markets for these reliability services, much like we have for other ancillary services? I think it's fun to be part of that, about let's figure this out. There are problems out there that are good engineering problems that are still going to have to be worked through.

Interviewer: Mm-hmm, mm-hmm. Do you think that NERC standards, their updates or working through things will change the way that turbines and farms are engineered?

Interviewee: Yeah.

Interviewer: I'm wondering I'm sure they both influence the other, but—

Interviewee: Well, it turns out that with modern wind turbines that they've actually had a lot of these capabilities to provide voltage support and frequency support, but it just hasn't been asked for in a lot of cases. Because there might be some additional cost of doing it, in general, this has not been a requirement.

Even though it's a capability of the equipment. I think we're starting to think about with today's wind turbines, with today's solar smart inverters, the capability is there to provide these reliability services. The debate is how much of those services do you need? Where's the best place to get them? Because you don't wanna do something that's more expensive than from being the best source.

Should it be done through markets? Should it be done through interconnection requirements? Should it be done through standards? That's the debate right now, and we're still working our way through that.

Interviewer: Yeah.

Interviewee: It won't dramatically change the engineering because the wind turbines and today's utility-scale solar plants, anyway, already have those capabilities that are pretty much engineered in, or can easily be added as options.

I think it will change our use of those options and how we want to get those involved. The technology is there, it's not like we can't

support reliability, but it is a change that we'd be getting it in a slightly different way.

The big issue is that wind and solar tend to really use inverters. It's not like you have a huge spinning generator at a coal plant that's synchronized with the 60-Hz grid, right?

Interviewer: Right.

Interviewee: Solar is DC power, wind is AC power of a different frequency that you then convert, and both of those you then convert to the 60-Hz power we need on the grid. We're used to the large generators just all was being synchronized, and now we're using these other technologies like wind and solar, which use very sophisticated electronics and controls to do this. Which means it's different, but it actually has some advantages. I mean, there are things that it can do faster, for example, in responding to frequency. It can actually respond more quickly than a conventional coal plant could, but it's not exactly the response that we are used to. It's coming back to what we talked about earlier, that we've had decades to figure out conventional plants. Wind and solar plants are really—most of 'em are ten years old, right?

Interviewer: Right.

Interviewee: Maximum. It's been over the last ten years.

Interviewer: Yeah, even the ones that are from a decade and so ago—

Interviewee: Yeah.

Interviewer: - right?

Interviewee: Today's wind turbines are not exactly what we were installing 10, 12 years ago.

Interviewer: Mm-hmm.

Interviewee: It's not the same as back in the '80s and the early plants at the Buffalo Ridge.

Interviewer: Right.

Interviewee: For example, GE has told me that they haven't shipped a turbine that can't do automatic voltage control for ten years, and all their clients for the last eight years have had the capability to do

frequency response. Has it been used? Not always. In the case of frequency, not very much, but the capability is there because they had certain customers who started asking for it.

Other people would come along, and it would be the capability is there, we just have to figure out how we're gonna use it.

Interviewer: Mm-hmm. What I'm hearing is that we're not using the machines to their fullest extent, or their—

Interviewee: Well we—

Interviewer: - maybe to their most efficient, or am I hearing we need to figure out how to make it—

Interviewee: It's all about what's important and how you value different aspects, right?

I mean to-date, wind and solar have primarily been purchased just as an energy resource, and so the motivation is always to produce the maximum amount of energy, megawatt-hours, and deliver those to the customer. Now, if you want other services like frequency response or voltage control, there might be some increase in the losses or a slight decrease in the amount of real power you can sell, right? You're saying, well I want—

Interviewer: Mm-hmm, I see.

Interviewee: - a lot of energy, but I also want some of these other things.

Interviewer: Mm-hmm, mm-hmm.

Interviewee: How do you weigh the balance of that? What's worth more to you? How do I know what to give you when? If all you're buying is energy, all you're gonna get is energy. If you start valuing some of these other services as well, then you can get those. Capabilities are there, as I said, but what's the value? What's the motivation to use them?

Interviewer: Mm-hmm. Another thing that makes you think for a lot...

Interviewee: Yeah, I've been doing a lot of work on that area last year, and also starting to think about the changes to market design as we get to higher levels of renewables.

Interviewer: Yep, well that's where my mind just went as you were talking about that.

Interviewee: Yeah.

Interviewer: As well how NERC standards and the influence of MISO—

Interviewee: Yeah, and I just—

Interviewer: - on grids.

Interviewee: - am completing a paper with some of the folks from various ISOs and vendors and European partners as well, about will market designs have to change as we get to much, much higher levels of renewables? We're not done there yet.

The markets are still in their early days, and as the requirements change, as you change what you wanna get out of the market, you're going to have to adjust to market rules accordingly in some cases.

Interviewer: Of course.

Interviewee: In some cases the markets may already just respond in an appropriate way even though they maybe were not designed with that in mind. The supply and demand is a pretty good driver, right?

Interviewer: Yeah.

Interviewee: If you create the right market elements that can respond to a lot of unforeseen circumstances—

Interviewer: Mm-hmm.

Interviewee: That's the sort of thing that really keeping the market theorists thinking these days about.

Interviewer: Sure.

Interviewee: Are we on the right track, or do we have to re-think how we do some of these things?

Interviewer: Mm-hmm, mm-hmm. Yeah, and how quickly or slowly. I mean, you don't wanna rush.

Interviewee: No, that's certainly true when it comes to markets and policy and other things is there's—we'd all like things to happen quickly, once we make up our own mind about what they are, or even what they should be. With wisdom, you tend to see that there is some value in the deliberative process. There's value in getting people together to study the issue and to look at options, and to work out things like they did with the CapX lines.

Interviewer: Mm-hmm.

Interviewee: Your first design is not what you're gonna build, right?

Interviewer: Right.

Interviewee: By accepting all that input and that give-and-take and that discussion process, and really studying it thoroughly, you're gonna come out with a better product in the end. It might take a few years to do it, but in the long-run you're better off for it.

Interviewer: Yeah, yeah. Well, we didn't really talk too much about CapX in particular.

Interviewee: I don't know that much about CapX.

Interviewer: As I said, that's just fine, but I'm going to ask you one last question—

Interviewee: Sure.

Interviewer: - is if you just, any general thoughts that you'd like to share about any aspect of the project. I'm leaving it really open because—and yeah, but this is just an opinion question of what you think about it and—

Interviewee: Well, I have huge respect for transmission planners and people that actually try to get this job done. Because as you know, doing transmission lines, or even upgrades, is not for the faint-of-heart. It's a heavy lift.

These people are trying to plan out years and years in advance. Trying to read the future about what we're going to need, and then figuring out the process about how do we actually make it happen.

To be honest, I probably don't have the patience to be a transmission planner and to do what they've done here. I have a lot of respect for their ability to actually get the job done and prove

that you can get to the finish line on those. It's not easy. The approval process and having that cost-recovery is very complex, and getting people who appreciate the value for—overall society in some cases here, essentially.

It's difficult, and I think you mentioned earlier, people don't spend a lot of time—the general public doesn't spend a lot of time thinking about electricity, right?

Interviewer: Right.

Interviewee: We do an awfully good job with it. Maybe that's our downfall, but they take it for granted, and there's just a few people that really know how complicated this is. I'm thankful that some of those people have been involved with the CapX project and have actually been able to make this happen, because I know it's not easy.

Interviewer: Mm-hmm, yeah. Okay, one final question.

Interviewee: Sure.

Interviewer: Is there anything that—and again, another really general broad one, but is there anything that I did not ask about that you maybe thought I was going to, or that I should have?

Interviewee: Let's see.

Interviewer: I wanna make sure to cover all my bases, that's all.

Interviewee: You covered a lot of ground. What else is there? Well, the one thing that keeps being discussed that sounds like a good idea to a lot of people, and I think is, is do we need even more of a high-voltage backbone?

Interviewer: Mm-hmm.

Interviewee: Not just in our particular State or region here, but more broadly for the country. People like Dale Osborn at MISO, they've—MISO's come out with some transmission plans showing high-voltage backbone networks that would really connect our region with the rest of the country. At least the rest of the eastern part of the country. Projects like this look like they would be very cost-effective in the long-run, but they would be very expensive in the short-run.

Interviewer: Yep.

Interviewee: I think you also have even more problems with the transmission siting, and cost-recovery and—

Interviewer: Yeah.

Interviewee: - how to get this done. I personally like the idea about how do we do more renewables and also lower the prices of power for the entire country. I think we're doing a good job of that for Minnesota, for the northern Midwest. I'd like to see that spread more broadly, but trying to get enough transmission to actually do that is very challenging.

It becomes a state-by-state issue, or a region-by-region issue. It's not easy to build even higher-voltage longer-distance transmission lines.

When I initially came into the business, I thought that just seems very, very silly because you can show it would obviously lower the cost of power for the average citizen, but it's not the average citizen that makes the decisions sometimes.

Interviewer: Yep, no. You can't control everyone, unfortunately, but yeah.

Interviewee: This came on—

Interviewer: Now it's—

Interviewee: - came on with some of the early Department of Energy NREL studies, like the EWITS study.

Interviewer: Yep, yeah.

Interviewee: You could do the modeling and show that if we put high-voltage lines all the way from here into New England—

Interviewer: Mm-hmm.

Interviewee: - we could really lower the average price of power.

Interviewer: Mm-hmm.

Interviewee: Our prices of power might not go down, they might even go up if you actually could do that.

Interviewer: Right, because—

Interviewee: For the country as a whole, it would be a huge benefit.

I was disappointed we can't do even more, but understanding how difficult it is, I think we have to be very appreciative for what we're getting done.

Interviewer: Mm-hmm.

Interviewee: It has to be done one step at a time.

Interviewer: Well, I mean what we need is more people pushing for—

Interviewee: Yeah.

Interviewer: I mean, it's a bottom-up and top-down as well, and that's one of the things that I've been asking a lot of the State people and MISO people is how can we start thinking about a national system, and if it's possible, and what needs to happen.

Interviewee: Yeah.

Interviewer: There are lots of challenges that would—

Interviewee: What do you think would even—

Interviewer: - stand in the way.

Interviewee: - start to get us there?

Interviewer: What would start to get us there? Well, I'm not sure. There are a few ways that this can happen, but I mean first of all, we've got these ISOs that all act differently—

Interviewee: Yeah.

Interviewer: - as it is. Maybe what can be done from the FERC level to make them more cohesive to begin with. Because, I mean before you can start, it's like the state-to-state problem with the transmission lines siting. You can't always guarantee that they're gonna—the State's going to approve them to cross at the same point, but when the work is done correctly beforehand, then they will, of course, meet. It's taking that idea and putting that as a region.

Interviewee: Okay, okay.

Interviewer: We've gotta change the way the markets are integrated, 'cause they don't—

Interviewee: Yeah.

Interviewer: That's just one thing, and then of course the—just the straight engineering technology of it—

Interviewee: Yeah.

Interviewer: - getting things to connect.

Interviewee: Well, many people think that FERC has more power, more authorization under the law, than they actually use.

Interviewer: Mm-hmm.

Interviewee: You see this, that if they try to really push a broader, more regional design, then they get into a lot of pushback about states' rights issues.

Interviewer: Precisely.

Interviewee: Then just that overstepping the federalism approach and all this. It's ironic, though, that we federalized gas pipelines years ago.

Interviewer: Mm-hmm.

Interviewee: It's now much easier to build an inter-state gas pipeline than it is to do a transmission line.

Interviewer: Mm-hmm.

Interviewee: What's the difference, really? There's amazing pushback to doing more of this on a national level.

Interviewer: Yeah, but state federalism is strong. It's—

Interviewee: It's very strong.

Interviewer: - it's—

Interviewee: I think that also results in some of the differences you see in the different regions and in the different market designs.

Interviewer: Definitely.

Interviewee: I mean are driven a lot by what kind of state uses these things.

Interviewer: Mm-hmm.

Interviewee: It's also interesting, 'cause I've been able to meet a lot of the Chief Economists at some of the different ISOs, and they have very different philosophies on market design.

Interviewer: Sure.

Interviewee: Talk to the Chief Economist in ISO New England versus PJM, it's a dramatically different point of view, right?

Interviewer: Mm-hmm, yeah. Yeah, it's one thing that—I mean, I don't know because I haven't had the opportunity to—

Interviewee: Yeah.

Interviewer: - speak with or really do any research on some of the other ISOs, other than how I encounter them through this project. Elizabeth talks a lot about the different cultures within the ISOs, and how—and so that's why—that's why I think, right, maybe FERC needs to—

Interviewee: Yeah.

Interviewer: - use their power a little bit more. They can't just charge in like a bull in a china shop and say, "This is what we're doing now," so it's very—

Interviewee: Yeah, every ISO has a very different personality when you get in there and work with them.

Interviewer: Mm-hmm.

Interviewee: You can pretty much generalize their personality characteristics, and see it in lots of the different activities in the ISOs.

Interviewer: Mm-hmm, mm-hmm.

Interviewee: It gets to be interesting.

Interviewer: Yeah.

Interviewee: Some of them just want to—well, some of them have more of a stakeholder-driven process. MISO, for example, I think is more driven by stakeholder initiatives.

Interviewer: Mm-hmm.

Interviewee: Others are much more driven by the staff of the ISO themselves, coming up with a proposal about here's how we think we ought to do it, and you can comment and tell us what you think, but we're—

Interviewer: Maybe we'll listen

Interviewee: - gonna make the decisions, right? Whereas others will not even think about pushing back if there's stakeholder resistance at approach, or wait even for the stakeholders to suggest something.

Interviewer: Yeah.

Interviewee: You can do it both ways. It's quite a show to actually go around and go to some of the meetings and see their proceedings.

Interviewer: I would imagine. I would imagine—

Interviewee: Yeah.

Interviewer: - it's fun to be a fly on the wall going—

Interviewee: Yeah. Now you can call on—a lot of these are public meetings, and you can—

Interviewer: Yes, you're right. You're absolutely right.

Interviewee: - you just need a lot, you need a lot of time because they meet all the time.

Interviewer: Yeah. Well no, that's the beauty of it is that I can—it's like turning on the TV.

Interviewee: Yeah.

Interviewer: There's always—

Interviewee: No, you can get all the newsletters and—

Interviewer: - there's always something, yeah.

Interviewee: - see the calendars and stuff and just—

Interviewer: Oh, I am on those news—well, I'm on at least MISO's, and I have—

Interviewee: Yeah.

Interviewer: Yeah. Right. *[Laughter]* It's how I—

Interviewee: It's—

Interviewer: - it's how I spend my time. *[Laughter]*

Interviewee: Well, especially in some of the ISOs, I mean, there's just so many people that make it their full-time job, just to participate in these things. Consultants and others.

Interviewer: Yeah, yeah.

Interviewee: It's interesting.

Interviewer: Yeah, I'm glad you think so too.

Interviewee: Can be frustrating.

Interviewer: Mm-hmm, yeah.

Interviewee: Yeah. The other thing that other—I don't see this much at MISO, but it's very tempting to come up with a cost-causation cost-allocation type approach to any incremental change you make.

Interviewer: Mm-hmm.

Interviewee: The principle is very attractive of saying if—okay, here's my system the way it is now, right? If I change something, whether that's build transmission lines or change some rule to allow you to come into the market or whatever, to the extent that that causes other costs. Should those costs be socialized for the system—

Interviewer: Mm-hmm.

Interviewee: - or should they be attributed back directly to the individual causers? Hard to argue against that as a concept, but it assumes that the status-quo you started with was right and fair.

Interviewer: Mm-hmm, yeah.

Interviewee: Historically, we've always aggregated and socialized a lot of the costs like the ancillary services costs, or the costs of contingency reserves for conventional plants that could fail.

Interviewer: Mm-hmm, mm-hmm.

Interviewee: Those have been viewed as just—you're not going to bill those back to individual plants or loads. It's all benefitting load, really. It's producing a more reliable, lower-cost system. Essentially all the things we do end up having a benefit to the lowest rate payers. You can drive yourself crazy trying to do slice-and-dice this and allocate this back, and then you still have to start with this questionable assumption about well was it fair in the first place.

Interviewer: Mm-hmm.

Interviewee: Just because we're changing something doesn't necessarily mean that this is a cost that the new guy coming in has to pay. We're seeing some tendencies in some of the ISOs for that, I think, 'cause it's—there's lots of interest and lots of established interest in these markets and regions and so forth. Everybody does as anybody probably would. You look after your own interests—

Interviewer: Mm-hmm.

Interviewee: - try to see what you can do for your business. It's certainly, I think, the role of FERC and the ISOs and the State Commissions and so forth to look at the bigger picture.

Interviewer: Mm-hmm, yep.

Interviewee: They do a good job of that sometimes like when trying to—MISO's really set a great example with their MVP lines as well on a broader basis. Building on the CapX—

Interviewer: Sure.

Interviewee: - utilities.

Interviewer: Mm-hmm, definitely.

Interviewee: I'm more of a let's optimize the larger picture and just lower the average cost for everybody.

Interviewer: Mm-hmm.

Interviewee: Guess that makes me a socialist, but—

Interviewer: It's just different perspectives.

Interviewee: Yeah, it certainly is. Yeah, I mean, I'm more idealistic I guess. Unfortunately too, sometimes it takes more of a crisis to really make things happen.

Interviewer: Mm-hmm, yep.

Interviewee: Once something does happen, things can happen amazingly quickly.

Interviewer: Mm-hmm.

Interviewee: That's certainly the way our federal government has been working, right? Some crisis comes up and things can happen. Find that consensus and get it done.

Interviewer: Mm-hmm.

Interviewee: You would've debated these things for 20 years and nothing ever happened before.

Interviewer: No.

Interviewee: It doesn't matter, doesn't mean it can't happen.

Interviewer: What will it be that precipitates the change?

Interviewee: Yeah. Well, I mean the interstate highway system was really motivated by defense issues, right? The way things are going, electricity may be cheap, but it doesn't mean that it's not hugely important for our economy and for our defense, and for just about everything.

Interviewer: Oh sure. I mean, the national security argument is a strong one.

Interviewee: Yeah, it's a strong one. We intentionally will design our system to be very disbursed and not as tightly inter-connected for liability purposes and things like that as well—

Interviewer: Mm-hmm.

Interviewee: - in terms of any reliability issues. We'll connect it to help reliability.

Interviewer: Right.

Interviewee: We're not necessarily—

Interviewer: Right.

Interviewee: - dependent on it, right?

Interviewer: Mm-hmm, mm-hmm.

Interviewee: That's a tough one. We don't always do what's most cost-effective or most elegant.

Interviewer: Mm-hmm.

Interviewee: I love it when we find an elegant solution to a complicated problem. I mean that's what I—

Interviewer: Well of course—

Interviewee: - love—

Interviewer: - it's nice when it's pretty and—

Interviewee: Yeah.

Interviewer: - works out neatly and—

Interviewee: Yeah, and we get some of those. We're seeing some of those pieces fall in place, but it's tougher when it's been an established system and it's been there for a long, long time.

Interviewer: Yep. Well I think that's a good spot to end.

Interviewee: Okay.

Interviewer: We could sit and philosophize for awhile longer but, yeah. No, thank you—

Interviewee: Sure.

Interviewer: - very much. It's been a pleasure.