MARTY ROSENBERG
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#302

ANDREW PHILLIPS INTERVIEW

Hi and welcome to Grid Talk. Today, we have a special guest, Andrew Phillips who is with the Electric Power Research Institute known as EPRI, where he is Vice-President of Transmission and Distribution Infrastructure. Hi, Andrew.

A: Hi, Marty.

Q: And based in North Carolina, is that right, Andrew?

A: Well, that's correct; I'm based in North Carolina. It's a beautiful sunny day but pretty cold. It's down to 30 degrees for us. For us, that's a cold thing.

Q: If you're like me and enjoying his accent it's because he's a native of South Africa.

A: That is correct, I'm from the deep south, south of the Equator.

Q: So, let's get at it. The reason that I'm very pleased to have you as a guest today is the Infrastructure Spending Bill that's been approved by the government is going to be dedicating $62 billion dollars to clean air grid infrastructure and you sit at a position at EPRI where you have your finger on the pulse of all the research that's going on for improving the transmission

grid. What do you think is in the scope of possible revolutionary developments from this investment? Just give us your first read and then we'll go down into some of the details.

A: Marty, there's a lot of exciting things that can be done to improve the resiliency and reliability of the transmission grid and it varies all the way from looking at installing DC lines and DC converter stations that will improve up the reliability but will also the controllability of the grid. But also, we have the opportunity and to build new transmission lines and not build them to the same specs and standards that we used in the '80s and '70s but to think of new ways of doing it that have higher power flow, higher reliability, and are more compatible with the environment and more compatible with the public and so there are lots of opportunities from controlling the power to building new transmission assets that's are right in front of us and you should take advantage of.

Q: Now at EPRI you lead the Transmission Sector Council which as I understand it is a group of 70-odd transmission companies from around the world. Their executives sit with you and brainstorm on these and the other projects and you're also responsible for about $56 million dollars of research activities at EPRI tied to T&D. Talk to us a little bit about what the transmission companies you are working with see is possible from this in-

frastructure spend and how your work at R&D at EPRI is going to inform what investments are made.

A: Well, Marty, I think the large push towards decarbonization and the goals that been set for us to achieve that transmission and distribution infrastructure is vital and the executives can see that. Not only do they have to build an enormous amount of new transmission to meet the decarbonization goals but they have to keep the existing transmission just as reliable as it's been in the past. At the same time, they also see that society is becoming increasingly dependent on electricity. You can think about digitalization, you can think about electric vehicles, and that it's possible that the reliance on transmission and distribution is going to increase and their requirements for reliability are going to increase and so we have moved from management speaking to the executives maybe 5-10 years ago, they were really just worried about operating the grid as they had it doing it in a cost-effective way and they realize everything has shifted to actually a large significant challenge. How to keep the existing stuff reliable and at the same time how to build a lot of new assets that can meet our nation's goals. And doing those two things at the same time are very challenging, so it's an exciting time for all of us, I think.

Q: So, part of the ambitions of the Bipartisan Infrastructure Law and the $62 billion I referenced is according to a statement put out shortly thereafter by the Department of Energy to expand transmission by 60% by 2030. That seems like a lot of transmission and does it seem like a lot? They also say possibly triple transmission by 2050. What's going on here?

A: Well, you know, I think to integrate all of these low-carbon resources and to allow for electrification we need the transmission system and we need to expand it exponentially almost for that 60% is huge. And so, when we stop thinking about doing that, we have to think about new tools that are in our toolbox and we can't just think about one solution, alright, we have to think about all of them. We need to think about how we can build new the transmission lines and when we're thinking about that, public acceptance and getting the rights-of-way and the access is going to be absolutely vital. We also need to think about how do we design new transmission lines that are more increased power flow on the new transmission lines. But then, we have to look at the existing transmission and say, can we upgrade it? Can we uprate it?

Q: Andrew, wouldn't that be the low-hanging fruit because siting involves plowing through virgin territory? Upgrading; you've got the lines sited already. Should that be the first effort?

A: I think you have to do them in parallel first and the reason is it takes so long to site and it takes so long to design and you'll lie with low power flow and we need to start that today. Actually, we should have started it five years ago. The saying is, when should you plant an oak tree? Twenty-five years ago, or right now? and so, we've got to do it right now. But I agree with you that at the same time, we need to look at increasing the power flow of existing lines and when we do that, we shouldn't think about just one method; there are actually four or five methods that we can think about using. If you'd be okay with me listing them, Marty, that would be okay. You know, the one that's talked about a lot is dynamic ratings or ambient adjusted ratings so that is adjusting the current in the line based on the ambient temperature or based on the ambient conditions. That can get you really modularly increases. Some days it may even reduce but you can get maybe 15%-30% but there are other opportunities. Can we increase the voltage of our lines and at the same time keep the reliability the same? Those lines we had were designed in the '60s and '70s based on EPRI research actually around the world, but they've got a lot of extra safety margin or I would call it, fat in them that we can use today to increase the voltage of the lines they say from 230 to 345 kV with minimal adjustment, increasing the power flow significantly

and so we need to think about that as an option. We also should think about taking existing lines and moving them from AC to DC. There is possibilities depending on how you do it on the voltage level that you can double the power flow down the line by converting from AC to DC. Now, the converter stations, really expensive but you have the land there probably already; you don't have to get the whole entire right-of-way along and acquire that and go through all the public hearings, so thinking about that. And finally, which is maybe a little…sometimes people would say, "heck no", would be, can we use our existing right-of-way's and put underground transmission lines or upward, overhead, above ground underground transmission lines, you know, above the ground, along those rights-of-ways? Traditionally, we don't want to do that, right, because we say well, we don't want the one line to interact with the other but we can make that happen and through engineering, address those.

Q: Can you clarify on that? You're saying put underground on to existing overhead transmission?

A: Yeah, so you've got an existing right-of-way; it's got an overhead line on it. Could we increase the power flow by underground, alright, putting a cable, not digging a hole and putting a cable but on pedestals or just above or just below the ground,

put them underground and a cable, alright, on the right-of-way; maybe a DC cable along the along these lifts.

Q: Is there any technical challenges to that or…?

A: Well, yeah, there's quite a few actually. One of them is the interaction between the overhead line and the underground line. If it's a lightning strike, it's the overhead line that's a big antenna. Overtones flow into the underground lines. Will they cause the underground line to fail? That would be one challenge. Another challenge is the interaction would cause corrosion which seems…is pretty minor which is a minor thing but the pipes that the cable is in can start corroding the soil and corrode the overhead line and reduce currents so that would be another challenge for us to deal with. But these are all just engineering challenges. Another challenge, by the way, would be when workers say, "Well, I need to get to the overhead line and now I'm going to have this thing on the right-of-way that's going to be in the way. You know my truck; I can't park my truck here to get access." But these are all just engineering challenges that with thought and investment, we can overcome.

Q: So, there's a lot of expenditure going on by the industry; always has been according to the latest data from the EEI. Utilities are spending about $140 billion dollars a year on capital expenditure. About a third of that or $46 billion goes into

transmission; excuse me, distribution and about a fifth or $29 billion goes into transmission. You put that money along side the $62 billion; is it going to be a game changer to have this infusion of Federal money or do we have to worry that the transmission companies cut back some of their own spending because of the federal dollars flowing in?

A: It's a really interesting, insightful question that I actually haven't thought that much about. I don't think so. I think we are not going to be limited by money. Money is no longer going to be the limiting factor. It's going to be supply chain, workforce, and permitting; those are going to be the three things. If everybody's building at the same time and just remember that not only has the U.S. got a low-carbon goal that has to build transmission, but every other country in the world has to do it. The supply chain to provide transformers, insulators, structures, is going to be strained.

Q: So, let's go through the three, one by one. Supply chain: can we control it within the United States? How dependent are we on foreign producers?

A: We are, I would say, on the transmission line side, I don't think we're that constrained from the overhead lines, being the insulators, the conductors. In terms of the manufacturers are in the U.S. and manufacturing devices; they'll have to ramp up

their production but it's not like we don't have the expertise or the production facilities already in place. I think the biggest limitation most probably is going to be what I call the term equipment: the transformers, the circuit brakers, and the power of electronics for it if we're going to put DC in, where most of those are internationally-based.

Q: Is there an opportunity here for EPRI, the industry on its power of energy to spur more domestic U.S. production of these critical components now?

A: Absolutely and it makes the supply chain more robust and us being a far more resilient country and not from a point of view from somebody stops…if we have a large pandemic and we can't ship things from one place to another place, right, we become far more resilient. We've got our transformers manufactured in the United States. It's a huge lift to do that though, Marty; it's not trivial. Does that make sense to do?

Q: Um hum. Now the workers; we're getting closer to full employment in this country. Will the workers be there? Will the linemen be there? Will the…there's a massive 60% expansion of the grid is going to create a lot of new jobs. Any estimates of how many and where do we get those workers?

A: I don't think we have got a feeling yet of how many workers and I…and maybe somebody's starting to work on it and publishing

results but I think it's because it's going to be very dependent on what type of assets we're going to put in where, but I would say, the challenge that we see is when we look at our utility workforce, a significant portion of the field workforce is getting older or getting closer to retirement so it's not just taking what is the existing workforce and have a significant amount of attrition coming up. Also, as you said, we're getting close to full employment and the types of jobs of being in the field constructing things is maybe not as attractive as doing AI, data programming or something. So, making it an attractive field that the available workforce wants to go to and at the same time addressing attrition, and then the last part would be…the way that we have traditionally taught utility personnel is through experience. We may do a lot of training but in the end, you become an expert from becoming just a regular Joe on a line crew to one day becoming a journeyman. That's by just working over 5-10 years and we're going to have accelerate the speed at which we bring people up-to-speed and make them very competent. And not only on the workforce but on the engineering force.

Q: So, accelerating that speed goes hand-in-hand with the third question which is the permitting challenge.

A: Yes.

Q: Does the industry see an opportunity to do a major PR campaign to prepare the public that this is not just business as usual. We're dealing with climate change. We're dealing with a massive infusion of Federal dollars. We're dealing with an interest in transforming how our grid works by having more points of production, more transmission…excuse me, more generation of wind and solar, and increased hydro. It's going to be a much more multi-valent grid. Do we have to explain this to the public so that things like opposition to permitting may be get to an extent, nipped in the bud?

A: You know, Marty, that's a little bit out of EPRI's realm from being a fact-based science, non-for-profit organization but I will say, some of the things that I hear is one of the challenges with transmission specifically is that the places that you need to get permitting don't necessarily get benefitted by the transmission so, if there's a windfarm in Upstate New York and the transmission line is to go through the whole of New York to make it to New York City, the beneficiaries aren't the people at the windfarm at the one end and it's a suburbia at the other end or the load center at the other end. The people in the field that have the transmission line that have to go over their land or maybe don't even own their own land, they've got to just see the transmission line as they drive to work every day or sit on

their back porch, don't necessarily themselves see the benefit of it; it's benefitting others. And I've heard that's one of the challenges that you have in trying to convince people because you're not convincing them for their direct benefit. The explanation has to be, it's better for the planet and it's a really, quite a tough sell. So, that's really out of EPRI's realm being on the public policy side, I guess.

Q: Right, but you're an eloquent and engaged expert so I wanted to elicit your opinion and I'm going to ask you another question, which is, climate change has put increased pressure on grid reliance. I was down in New Orleans visiting family when Hurricane Ida hit and subsequently learned that a lot of the lines built for specs to withstand 90-mile-per-hour winds were suddenly vulnerable when there were 150-mile-per-hour gusts. Given the research going on at EPRI, how close are we to getting to where we need to hardening the grid against increased violent weather events?

A: Well, maybe I'll just describe what EPRI is launching at the moment and then maybe hopefully answer your question. We realize that transmission lines that we build today will stay in service for 80 years and in some cases, we have ones in Upstate New York that are 100 years old, right, and so we need to think about when we build them today, what is the spec that we use to

build that line to that has to work in 2050, 2060, even later than that. And so, in the past what we would do is look at a hundred years of data behind us and we would say, "Well, a hundred years, we'd have one failure." We'd work it out that way. The past is not a good predictor of the future at the moment. We know the climate is changing and we're expecting far more extreme events and so we have started an initiative which is, how do you take all of that extreme weather data that is being predicted for 2050; how do you take the increased temperatures that are predicted for 2050 and how do you as a utility company, take it and change your specification today? Change maybe what your maintenance practice is today so that you can account for what's going to happen in 2050?

Q: And that question becomes increasingly important as you're aware, we're on the cusp of spending now massive amounts of money.

A: Absolutely because all the assets we put in, they're lost for a long period of time and they, actually our reliance on them gets more and more dependent. Transmission lines are interesting things. When you put them in you actually don't use them to their full extent for the first few years because you're using them for the future load and they just get more and more and more used and they also get used in ways that they weren't pre-

dicted to be used. Fifty years ago, you didn't predict it was going to be loaded to that level.

Q: Give some concrete and possibly dramatic examples of what your research is showing, what we'll need for 2050 and what are some of the specs you're coming up with?

A: Well, I'll give you an example it…which it isn't always that obvious. We've been looking at what the hottest day and the slowest wind will be in Texas in 2050 and realizing that it means that the rating of the overhead lines will probably be down between 7% to 15%. Because you know the rating of our lines, we base it on what is the hottest day and what is the lowest wind speed. Well, if we have extreme days in Texas, in the Houston area in this case, which are much lower in 2050 than they are now from a windspeed point of view and much higher from a temperature point of view, the rating of the lines are going to have to be derated by 7% to 15%. And so, we should be building our lines today saying you know what, we need to add that 7% to 15% so that we can use…have it available to us in 2050. I know it's quite an extreme example and it's not like you were probably expecting hurricanes and tornadoes so it's a little bit different but it's very concrete and it's very real in what we're finding.

Q: And if you build towards that day in August 2050, what capability does that give you in the next 10-20 years?

A: You know, when you have this extra fat call it on the top, this extra headroom where you could use it for extra flexibility, you could use it to enable you to build other lines, so delay projects that you needed to build; it could help you with that as well so, Marty, I've never thought of that as an opportunity in the short term where you get by going towards the long term and that's a really good thought. I really appreciate that.

Q: Well, that's why we want you to continue to listen to Grid Talk.

A: Okay, Marty, definitely.

Q: So, you oversee centers in Charlotte and Lenox, Massachusetts.

A: Yes.

Q: Talk a little bit about…give us a flavor of the work being done there and why the industry should be excited and paying attention.

A: First, Lenox is one of the national wonders of the United States and it was built in the '60s and it was built to help design the transmission lines we have today. It's the most amazing place and it's an outdoor high-voltage laboratory where we design lines and if I give you a good example, over the last few

years in the last decade, we helped AEP develop, design, test their new VoLTE structure; I don't know if you've seen that VoLTE structure which is much shorter than the normal 345 kV line. It has higher power flow and without that lab doing that high-voltage testing, we would never have been able to enable that to be done and it was a fantastic effort of five years teaming between EPRI and AEP and it's outdoor high-voltage that does simulates lightening and voltages up to almost two mega-volts and switching surges and everything you can imagine. Also, in Lenox we're designing the distribution structures of the future and we have a site where we actually impact distribution lines with simulated trees so that we can see how they will react so that the poles don't break but the insulators just snaps or the cross-hold snaps, speeds up recovery, and 10 utilities are actually implementing those new designs today so it's the most fantastic place.

Q: And do you have robotic squirrels or trained squirrels that you can test their interference?

A: Actually, we have…we don't use robotic squirrels but we have little cages that we have made that look like squirrels and that actually look like humans and we put in the electric field to simulate them so we call the mannequin which is the human, we

call him 'Chicken Charlie' because he's made out of chicken wire and he looks like a 'Chicken Charlie.'

Q: Okay, give my best to 'Chicken Charlie.'

A: I definitely will. In Charlotte we have a new…is more about underground cables and sensor development, and one of the exciting things that we've done…we're doing in Charlotte is in our big cities like New York and Chicago, our cables are in pipes filled with oil at 200 PSI, and we really want to put the new types of cable, plastic cables – we call them XLP cables, and get rid of the oil out of the ground and we haven't been able to do that until recently. And EPRI's just patented it and is working with SAMP Wire to actually have a cable that will fit inside those existing pipes that have no oil and so it's going to be much better for the environment. And so, Marty, if you ever can come to Lenox and if you can ever come to Charlotte, there's so much to show you. I would love you to come.

Q: Okay. So basically, are you looking to put more underground pipes into possibly abandoned oil pipelines? What's the relevance of that?

A: We're looking to take the cables that are in the pipes at the moment up to New York City, Chicago, and even Alabama; take those existing cables up, flush the oil out and put cables in that are basically, we call them cross-linked polyethylene but

that cables with plastic in terms of insulation; put them in and have the same amount of capacity as you had with the oil because the oil is a really good thermal insulate conductor as well as a really good insulator.

Q: Just really quickly, one of the arguments for undergrounding is greater resilience in terms of a lot of weather problems. Do you see a possible breakthrough against the main hurdle which is cost; is there a way to get the cost down?

A: I would say the main hurdle for cost is really, mainly in the distribution space. I'll put that as the main hurdle in distribution space and I haven't seen any large breakthroughs. We… EPRI's been trying quite a few breakthroughs for years but we haven't found anything that will break the cost and we're actually going to more of an innovate approach for now for the last year or so, we were trying to get startups, innovative hubs to come up with solutions and for us to evaluate them rather than using the five experts that have been trying to for the last 20 years; rather crowdsource may be the solution or use the markets to come up with this solution, Marty. For transmission cables, although cost is a big issue, the real issue is for AC cables; you know, you can't go much more than 30 miles because of the impedance, the induction of the cables and the capacity of the cables and you would have to use the DC cables. So, the limiting

factor really in AC cables is really more distance than anything else, and then construction cost, although construction costs are not far behind.

Q: So, my last question to you is traditionally there's been the observation that utilities as an industry spend a smaller share on R&D than most sectors, dramatically smaller, and EPRI was created, I believe, to address that or help address that. What's your sense of the moment we're in right now with all the spending coming in terms of EPRI's role what has been historically and where it might go in the future?

A: So, one of the interesting little factoids that I've heard is that we're…we spend less on real power research in the United States than we do on researching new dog food. That statistic is out there somewhere, which is very interesting. I think we're at a historical moment and we need to build back better, alright? We don't need to build back with the same stuff that we designed in the '70s and '80s and there's a definitely an opportunity there for us to do it. EPRI is really well-positioned being so collaborative with so many utilities in the United States being a member but also internationally. A third of our members are international and that experience and expertise that they share with us but they contribute in the collaboration I think is going to make a huge difference, so we are extremely well-posi-

tioned and I think that collaboration is king to really solve this. It doesn't matter how smart you are, no one person can solve this so collaboratively is how we need to do it.

Q: Great. Thank you, Andrew.

A: Oh, it's a pleasure and Marty, I appreciate all of your leadership with this podcast. It's fantastic.

Thank you. We've been talking with Andrew Phillips, who's Vice President of Transmission and Distribution Infrastructure with the EPRI, Electric Power Research Institute. Thank you for listening to Grid Talk and please send us feedback of questions to at GridTalk@NREL.gov. We encourage you to give the podcast a rating or review on your favorite platform. For more information or to subscribe, visit SmartGrid.gov.

END OF TAPE