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RON AMBROSIO INTERVIEW

Hi, and welcome to GridTalk. Today we have with us Ron Ambrosio, energy transformation professional who's spent lots of time thinking about the grid, where it's been and most importantly, where it should be headed.

Q: Hi, Ron.

A: How are you doing Marty?

Q: I'm very pleased to have this chat with you and we're going to go very far, very fast. The reason I reached out to you after tracking your career for many years through IBM and the GridWise Architecture Council; we'll get into that in a little bit. I'm seeing and we're all seeing lots of government resources being directed to the grid through various programs coming out of COVID to stimulate the economy. You've got the Department of Energy spending tens of billions of dollars. You have the EPA administering the Bipartisan Infrastructure Act and the Inflation Reduction Act going to all corners of the grid so I think it's a good time to pause and just consider, is this money being spent as effectively and of focused a fashion as possible,

and what are the consequences if we don't get this right going forward?

A: Yeah, I agree with you; it's the perfect time to ask this question. In the Architecture Council, the topic that we've sort of centered on over the last two years or so has been the importance of grid architecture as a tool, as a methodology for helping make sure that we are as efficient as possible, economically, as possible in making this transition and one of the key themes that we're trying to educate the industry on is the importance of not just looking at forward incremental steps and design as we go from today's system to a future system with very high penetration of variable renewable energy and distributed energy resources but also the importance of looking at that endgame and doing analysis on that from an architectural perspective and working backwards to see where does the forward path and the backward path meet, and are we taking the most efficient forward path.

Q: The consequences you and I have chatted offline could be not millions or billions, but trillions of dollars of loss.

A: Yup.

Q: Give me an idea of why this money sum gets so large so fast.

A: So, there's been work done by the Pacific Energy Institute; Paul De Martini has been part of that, identifying as we go through sort of this; think of sort of today and recent years as being significant renewable energy and DER penetration, eventually want to get to very high penetration but we're now entering that sort of mid-ground, that high-penetration and their analysis has identified a concern that if we just keep on taking today's electric grid systems and moving forward incrementally, at some point we're going to start to run into constraints in the inherent design of today's systems, and that, if we don't plan correctly, if we don't know where we're going in the endgame, we're going to end up with a sort of a step function of correcting, having to start thinking about a completely different grid design that will allow us to reach that very high penetration. A good analogy of that, Mark Patterson who is one of our associate Architecture Council members from Australia and who we've collaborated with for years, he uses the analogy of building a bridge from both sides and you want to make sure that bridge meets in the middle. Think about the cost of making a mistake and having to correct it when you find out, oh, I'm off by a foot; one side is farther to the left than the other side. That costs a lot of money to fix. This is sort of analogous and that's where it could become trillions

that didn't need to be spent if we are more careful about understanding from a forward back, back from the future sort of analysis, and an incremental forward analysis to make sure that things are heading to a middle point that minimizes that step function as much as possible and manages it.

Q: So, you've set the stage perfectly and I'd like us to just take a side step for a few minutes to talk about your background and why I felt you are the perfect person to engage a conversation on these topics. You were at IBM for 36 years where you were the chief technology officer for the Smarter Research Energy team at IBM's T.J. Watson Research Center where you had 20 people working in Yorktown and a total of about 50 or 60 in various research centers. In addition to that you were a founding member of the Department of Energy's GridWise Architecture Council where you continue to serve and after you left IBM, you started a spinoff company, Utopus Insights, that was involved as I understand it, with a utilities analytics tools, and products.

A: Yeah, energy analytics, yup.

Q: So, you've got the perfect background I think to talk about this question. You talk about building back from the endgame. Is the endgame ubiquitous renewables backed up by some clean non-

greenhouse gas-emitting reliable energy source? What does the endgame look like? and then help us walk backwards from there.

A: In a nutshell, yes. The endgame is reducing carbon fuels trying to depend on renewable energy more and more and also for reliability purposes as well, trying to expand to the use of distributed energy resources; storage, things like that, so that we're not only having a positive impact on the environment, but we're also hopefully increasing the reliability and resilience of the grid especially as you start to have more and more rooftop solar and other things, in addition to bulk wind and solar farms. The grid is becoming much more dynamic but it still needs to maintain balance between supply and demand every second of every day so you're talking about an architecture that has a need to be highly distributed and very stable at the same time.

Q: So, in terms of dates, when do you think we will be at the endgame? Will it be in this decade? The next decade? How much time do we have?

A: Well, the endgame, we may never reach the endgame because even what we're envisioning today with 2050 plans and things like that, is it enough to manage climate change? That's always a big questions so if we take a step back from that and say, let's call it 2050 targets, where do we get in the next five years? Ten years? I think we're at the point where were starting

to make that transition from something that can be managed well with today's design in the grid, today's architecture, to something that starts to hit its limits. It wasn't originally designed to be a highly dynamic, fully integrated system from bulk storage all the way to customer premises so at some point, we believe we're going to start to run into some limitations on existing grid architecture and that's why it's important for us to take a look at well, where do we need to be in the end from an architectural point of view?

Q: So, who has the responsibility for that? Would it be FERC? Would it be state regulators? Would it be a private group of utilities operating in a consortium? You talk about it domestically and then talk about it internationally. To what extent do what we try to do in the United States mostly link up with Europe and the rest of the world?

A: Yeah, some parts of the world are farther along. I think Australia has been doing a lot in pushing the envelope. They are also a good place to look for what sorts of challenges are we going to run into. The answer is, it's not one entity that's responsible because we're talking about change that has to occur not only at the interconnect level of the grid level and we have three in the U.S., and what FERC is responsible for from a regulatory point of view is bulk generation and things like that

and interstate commerce but also at the state and local level; muni's and public utility districts and everybody's got to be part of this. I think that DoE has an enormously important role in helping to identify some of the areas that should have investment and to both provide perhaps some early investment to test whether certain approaches are working or not, and that's a role that DoE has always played in pilot projects and things like that, but I think the regulators also need to understand how their role needs to focus on making sure that they're enabling these kinds of changes through regulatory and policy issues.

Q: So, to what extent is the whole regime we're dealing with now of DoE involvement? FERC involvement? tied to the ways of the past and when you talk about looking back when you visualize the future, do these institutions necessarily evolve to handle that or do we need new institutions in place do you think to make it happen?

A: I don't think that we need new institutions. I think if look at DoE and the lab structure, places like PNNL are involved in looking at this issue. A lot of their work has been picked up by the Architecture Council, for example, their work on grid structures and modeling the grid as a collection of structures. That's an important grid architecture methodology and so I think

with the right investment, the current lab structure is a tool that can be leveraged and can continue to be what's its been in the past with forward-looking kinds of projects that test and maybe validate various different approaches.

Q: When you talk about making sure investments are made efficiently to avoid waste down the road and you see regional transmission organizations sitting on a backlog of projects because the grid cannot accommodate them, how do you deal with a problem, an impasse like that; I mean, is that something that could be addressed looking backwards from the future? Can we proceed in a different fashion? How do you analyze that bottleneck and that problem?

A: I think that bottleneck partially reflects the fact that our current grid design does have limitations in what it can absorb today. You're always going to have the issue of needing new transmission, ultimately wires have to be installed as you deploy more, especially large-scale wind and solar. But, there's also the other end of the spectrum where we need to be able to accommodate more distributed variable renewable energy, rooftop solar, smaller community types of farms, whether they're solar or wind, and looking at how do we put them closer to the load pockets? They're smaller, there may not be as many issues in locating those types of smaller resources closer to the load

pockets and therefore, you don't run into the problem of needing massive new transmission lines for everything, but you do have to make sure that the perhaps the distribution grid attached resources that the grid can handle those as well so again, in the end, we need to understand what the grid looks like down the road in order to accommodate this very high penetration or renewable and distributed resources. Yeah, it's not just a matter of it's FERC's problem or it's the state's problems or it's the IOU's or it's somebody else. This is an approach that needs to be consistent across all of these bodies and they each learn from it. The policy and regulatory entities should be able to get informed by work going on in grid architecture that lets them decide whether the best regulatory rules to be put in place to enable work to go forward at both the state and at the FERC level because changes have to occur in both areas.

Q: As more storage and distributed resources get deployed and renewables as well, do you think necessarily the game shifts more much more to the distribution to long-haul transmission lines marching across the countryside?

A: Well, I think that; I think that there's a lot of evolution that the distribution systems need to go through in order to accommodate very high penetration of more distributed renewable energy and other types of DER resources. To some extent the

expanding the transmission grid is more a matter a rights-or-way and things like that. We know the technology; that's not so much the challenge but when we get down into the distribution grid, today's grids probably aren't in most cases, well-suited to very high penetration of renewable and distributed resources, so I think a lot of the focus has to be put there but it's part of a larger grid methodology and grid architecture. We're really looking at in the end, an architecture that at the extreme could be looking at from zero to 100% supply from bulk at any point in time and that the distribution end from zero to 100% being supplied locally and most of the time it will be some mix, constantly evolving mix of the two. That means we need a highly distributed and flexible grid architecture and control methodologies that allow the different entities that manage those two ends of the spectrum to interact and interoperate in a highly dynamic fashion.

Q: Ron, we first met each other more than a decade ago with various GridWise Architecture Council meetings in Portland on the subject of transactive energy.

A: Um hum.

Q: How has that evolved over the years and how close are we to getting energy electricity real-time priced and having that affect consumer behavior?

A: Well, I think transactive energy is a, yeah, a much more common term today. There are various variations of what transactive energy means but I think that we've made a lot of progress in starting to incorporate transactive ideas into primarily on the distribution end of things and the boundary between the customer and the distribution grid, but transactive energy can be applied even in the bulk system if you think about a maybe a combined wind and solar farm with largescale batteries. Now you're talking about three different dynamic resources that could be using transactive techniques to help manage the balance between those because they're receiving transactive signals from the load end of things in the distribution grids. Do I think that transactive has reached its zenith? No, I think it's something that's still fairly early in its deployment commercially but it's something that is much better understood by the industry than it was 10 years ago when the Council really started to push it and then the early work going back 20 years with PNNL and projects like the Olympic Peninsula demonstration and then the ARRA-funded Pacific Northwest marquis demonstration which were both transactive energy projects that Battelle oversaw. The Pacific Northwest demonstration, that one was a very successful demonstration of transactive techniques across Bonneville's entire service

territory and we had 11 different utilities involved in that project. I was the chief interoperability architect and my team from IBM Research was working closely with all of the utilities and with PNNL on that implementation for five years.

Q: Is there any way to take the topic of transactive energy and relate it as a tool for sending the economic signals that helps us get more clearly to the grid of the future?

A: Well, I think transactive energy is one of many tools for using economic signals. I don't like to say prices because the reality underneath transactive energy is, it's a distributed control system that translates all of the objectives and constraints into economic values. Those economic values can then be used to drive dynamic pricing if a particular regulator wants to have customer boundary or it can be used in other ways. It's a signal; it's really an interoperability mechanism by translating everything into representative economic value signals. In the Pacific Northwest demo, we were translating into the cost of energy delivery throughout the system and they don't have dynamic prices anywhere at the time in the Northwest but we were still able to implement this by using other incentive mechanisms, driving savings on the monthly bill or something like that but that underlying plumbing was there that you could have a mixture. Some customers are going to be responsive to an

economic price signal; others aren't, so it also depends on the customer segmentation. Some people are already on a tight enough budget. What are they going to do? Turn off their refrigerator in order to save money? So, that's something we learned on the Olympic Peninsula project; who was responsive to these signals, and we found that the people that had a tighter economic budget couldn't be as responsive. The people that had a more affluent budget didn't care. They were willing to pay the money to use the electricity and it was really that middle ground that was the most successful in responding and that was an important lesson to learn, and transactive as an underlying mechanism is an important tool but it's not a panacea for everything. There's still other methods of influencing customer behavior that might not just be purely transactive.

Q: So, Ron, the last question I'd like to ask you is that given your 36 years at IBM, given your two decades work with the GridWise Architecture Council, as we sit here today as you look at over where the grid needs to go to avert losses or achieve savings of trillions of dollars, are you optimistic we'll get it done in the next 50 years? Are you concerned? Who would you like to have address this, and if you can get the right people in the room as the play *Hamilton* says, "with the decisions that happen, what would you tell them?"

A: Well, a number of years ago there was a meeting convened with DoE and NIST and FERC of sort of bring together experts on future grid architecture and that in many ways was part of what eventually evolved into where the Council is now focused and so I was at that meeting, and other members of Council either then or who have become members were at that meeting. I think it's important to keep having those sorts of cross segment technical and policy discussions so we really need to have NARUC at the table. We really need to have DoE at the table. We need to have the bigger investor-owned utilities that have the capability to explore new technologies as opposed to the small guys who are often looking at the industry to decide well, where should we put our money after a particular approach has been proven? And we also need to have the standards bodies involved so I think that having regular conferences with the theme of the evolving architecture of the grid and what we see as the demands of the future, that's one mechanism. You're familiar with the Architecture Council's first Grid Interoperability Forum conferences for many years, then we were running the Transactive Energy Conferences. In the last year or two, we've now started to focus on grid architecture as the theme of our annual conferences and the next one's coming up in September, co-located with RE+ out in Anaheim, but it's not just the Council.

There's lots of different entities that can be taking this kind of a role whether it's IEEE or if you look more internationally, IEC; it's really more of a discussion in the industry that has to be had and has to be socialized so that it becomes a way of thinking about how we need to keep moving forward and addressing the challenges.

Q: To bring it to a point, are you confident these conversations and getting the meetings going will get us to the place we need to build the grid of tomorrow?

A: I think the alternative is not a possibility; we have to. To be frank, we have to do this and do I think we'll get there? I think we'll get there and the question is, will we get there efficiently from an engineering and a from an economic planning perspective and an investment perspective, or will we get there inefficiently, in which case it will cost a lot more money and we'll run into more problems along the way and that's really where we're trying to educate the industry now on leveraging tools that are emerging around grid architecture and around modeling and things like that, and also, from a requirements analysis, not just looking at what the next step is but the importance of looking at the endgame and working backwards to make sure we're heading in the right direction so as we think about the backwards analysis as building a bridge from one side

of the river and the forwarding incremental traditional analysis as the other side being built, we want them to meet in the middle or else it's going to cost a lot of money and it's going to be a big problem, so I do think we'll be forced to succeed because the alternative is not acceptable and it really boils down to a question of how well do we achieve this? How efficiently and economically do we achieve this?

Q: Thank you, Ron.

A: Thank you.

Q: I look forward to meeting you at the middle of that bridge in 2050, and shaking hands and maybe hoisting a glass of Pacific Northwest wine.

A: Nailing the golden spike into the bridge.

Q: Yes.

We've been talking to Ron Ambrosio, energy proficiency professional and an energy transformational professional. Thank you, Ron.

Thank you, Marty. Good talking to you.

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