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ELLIOT MAINZER INTERVIEW

Q: Hi, and welcome to Grid Talk. Today, we have the pleasure of speaking with Elliot Mainzer who steers the Bonneville Power Administration in the Pacific Northwest. 80 decades plus in history has had a major role in the evolution of electricity in that region across the country, and we're going to be talking to Elliot today about where his grid is headed, where the federal grid in the Northwest is headed and what the implications are for the rest of us. Welcome, Elliot. How are you today?

A: Thanks, Marty. Great to talk to you. Pleasure being here too.

Q: Let's talk about what you see as the major opportunity for evolving the BPA grid as it serves primarily Oregon, Washington, Idaho but plays a role throughout the West. What are the opportunities you see in the coming decade that really excited you?

A: Well, there's quite a list. I think, as you know, we operate over 15,000 miles of high-voltage transmission here in the Pacific Northwest, our big network, and of course, we manage interties that go up into Canada and down into California. For many years, we've sort of been the backbone of the high-voltage grid up here in the Pacific Northwest, and for many years, the job was pretty straight forward. It was making sure we could get hydroelectricity on the Columbia River and the other resources that have been developed over time and delivered reliably to the load centers across the region both at municipal utilities and some of the big [unclear], and of course, many of our smaller public power [unclear] rural parts of the region that were really established back in 1937 for the expressed purpose of rural electrification and connecting [unclear]. The last 10-15 years has seen some pretty significant changes in the generation profile. Back in the period of 2007 to 2012, we had an enormous amount of wind energy development and our transmission system had quite a bit of capacity. In the federal grid, we also built and expanded some lines, and we were able to enable over 5,000 megawatts of wind energy.

Q: Let me stop you right there. Elliot, do you think your accommodation of that wind power on your grid is as profound a shock posed by renewables in any part of the country?

A: I think we certainly had one of the highest concentrations of wind energy in the country, certainly other parts of the region as well like Texas and [unclear]. I would say at the time, a particularly fairly concentrated wind development. We were right up there with one of the most highly-concentrated [unclear] in the country, if not the world.

Q: It created some aberrations, did it not, because of the demands of coordinating with water flows for fish conservation on the Columbia and other rivers throughout the West?

A: Yeah, it did. There were some growing pains for sure. The volatility of the wind forced [unclear] from the system that [unclear] Pacific Northwest where we get into the middle of the spring, early summer with lots of runoff and concerns that there was too much dissolved gas happening on the river because we were having to spill a lot of hydro to accommodate all the wind that was coming out of the system at the time. We had some pretty tough conversations with the wind energy community. We eventually got that issue resolved and behind us. Now, we've really been turning to the fundamental question of "what does the next big wave of development look like?"

Q: As I understand, there's going to be backing off of coal generation that's been around for a long time plus an advent of a growing amount of customer-side generation as folks put primarily solar on to their properties. Talk a little bit about how that changes the challenge.

A: Yeah, that's right. We're seeing a multi thousand-megawatt elimination of coal fire generation in the West, and we have some very ambitious clean energy policy on the books in Washington state and other regions of the West. California has been up front about the topic for a long time as well. There's a tremendous amount of renewable development going on in the region. We're seeing a major turnover in assets. Some of the major utilities are replacing their coal plants with new resources, renewables, wind, solar, battery storage, so for us we have a lot of new technology and a number of key challenges. First of all, the market continues to evolve in terms of system operations. I think folks have learned over the last 4-5 years that we're not going to be able to accommodate the kind of renewable resource development that we're going to see if we're all operating in a balkanized fashion. We need to work more closely together as utilities and share our operations and share flexibility. We have seen that through the advent of the energy imbalance market over the last years to become part of the ISO. Just earlier this year, we signed an implementation agreement with the California ISO to get [unclear] ready to potentially join that market 2020-2022. That's a big opportunity for the federal system and our customers. Of course, I think, the other big challenge for us now is to try to anticipate from a transmission provider perspective what the pattern of development is going to be. Which of the big regions are going to open up with that? [Unclear] . . . Washington, Oregon. How much of the new generation will be carried at the distribution level and how much of a load will our system have to carry?

Q: Without getting overly technical, Elliot, your system evolved primarily to take the power from 30-31 hydro projects in various remote parts of the Northwest towards population centers. That's how it was designed. That's how it was built, and that's how you've deployed

15,000 miles of high-valued technical transmission lines. How does the challenge ahead require that whole architecture to be revamped? How much can you keep? How much do you need to throw out?

A: You know, well, I think a couple of things. First of all, one of the things we're definitely doing is we are-- with the grid that's been built over the last 80-odd years, we are making significant infrastructure investments not only to maintain that infrastructure to sustain it, but we're also modernizing it. We're investing in a lot of digital technology, new state awareness tools, new forecasting capabilities essentially to set ourselves for operating in a more automated market environment with our transmission grid, so that's something that Bonneville and I think many other utility companies are going through.

Q: Can you quantify what the capital investment is or give folks an idea of the magnitude of that?

A: On the sustained side, just the sheer just keeping poles and wires control centers healthy, we're investing over \$300 million a year in the transmission side, about \$250 million on the power side. Our grid organization initiative is focused very specifically on preparing for market entry and to be able to leverage many of the digital technologies. It's quite a bit of investment to try to be as efficient as we possibly can. I think there's a wide awareness by Bonneville and our customers that this type of modernization process is essential for us to thrive as the markets change and technology evolves.

Q: To put a fine point on it, your rates in the Northwest are, compared to the rest of the country, fairly low because of your abundant hydro resource. I would imagine that gives you quite a margin to tap without getting rates really high. It's really modernized the grid substantially.

A: Yeah, I think, look, this region grew up on affordable electricity. It's a fundamental underpinning of the economy out here, and we have, you know, particularly the last few years, as there's been a reduction in price of natural gas or new technology coming out, we've really sort of tightened our belt to maintain our competitiveness. We have power contracts with our customers that extend through 2028. We think right now, we're in a healthy competitive posture if you look at the values and the attributes and the key components of the power product that we sell to our customers. You know, we are ever diligent to keep our costs under control and to maintain our competitiveness. That is an advantage for this region, and now, this next generation of technology comes on, certainly by managing our costs and being focused on the bottom line, we have freed up some capital to be able to invest in modernization. So, yeah, it's working well, sort of maintaining our cost competitiveness, standing our financial strength while at the same time investing in the future.

Q: Focus for a second on energy storage. Quite a bit is being put into that in California, for example, to the extent that resource grows exponentially in coming years. How does it affect your grid and the region's larger grid?

A: We're going to be impacted by that in a variety of ways. First of all, as a transmission provider, we looked at energy storage as potentially a resource that we can use in our own transmission operation in certain contexts for congestion management and management super peak loadings in certain parts of the systems. We're very interested in how the technology is evolving. Many of the utilities in the region are already beginning to procure. Wind energy and solar energy products paired with battery storage, so getting those projects interconnected into the system and understanding how they actually provide capacity and what their duration is and how they perform real-time operations is of significant interest to us, and obviously, you know, as the technology evolves and during increases and costs come down, others, I think, will be looking for a wide variety of potential storage applications which is certainly a very exciting part of industry evolution.

Q: For folks that are listening that are not overly familiar with what's happening in the West, could you describe what the Western energy imbalance market is and what it's going to be doing in terms of your life and the life of customers on the West coast and the Northwest?

A: Absolutely. You know, for many parts of the country in the United States, they have an independent system operators or other entities that actually operate the grid. It's a fairly wide footprint. They effectively try to meet load at any particular moment of time with the least cost generation that's available. The West has, for many years, sort of largely rejected the idea of modern markets. We had a very affordable power, particularly up in the Pacific Northwest. Our public power utilities in Bonneville are traditionally non-jurisdictional with the Federal Energy Regulatory Commission. I think that reality was it just wasn't such a super strong business for broader market development. Over the last several years, as we saw increased amounts of renewable energy generation, more and more challenges of building capacity on the system, I think there was a stronger interest and sort of a new wave of emerged interest in building on a broader market in the West. After a lot of discussion, a lot of dialogue, finally, the California Independent System Operator several years ago sort of perked up and said, hey, guys, we've got a market for operating here at the state market. It's an independent system operator. It operates and has a lot of market infrastructure that's already built, we think, for fairly low cost. We can have people come in and have the opportunity to dispatch your resources in combination with ours, and every 5 minutes, we will look for who has the lowest cost generation that can be used to be able to serve load. Back, I think, in 2013, 2014, PacifiCorp in Portland decided to join that market, take that big step. It was really kind of a game changer at that

point. They established, with the California ISO, this energy imbalance market, and within a few years, many of the other utilities in the West decided to join it, and at this point, after the first several years of operation, I think they've estimated that it's generated over \$800 million of benefits to consumers through lower-cost dispatch by sharing some sources over a broader footprint. We've been watching the resource. We actually played a pretty important role in helping get it up and going in its early stages. We had to work cooperatively with the California ISO because many of the utilities up in the Northwest had to use our transmission system to get into California to trade with them, so we worked very constructively with the California ISO and others to get the market up and operating, and then we sort of sat back and looked at it from the business case perspective for BPA and our customers. Just a number of issues around governance, around policy, and our statutes just to make sure we could meet our fundamental statutory obligations by joining, and finally, earlier this year in the fall, we did conclude that there was a solid business case for Bonneville to join. Although we have not made the final go-live decision, we did find an implementation agreement with the California ISO in September which puts us on the path to going live in the spring of 2022. We think there's a good likelihood that we will eventually join. We will be filling in another big part of the map of the West amenities that are participating in this new market. The other thing I will add is that the market participants for the energy imbalance market are already at work with what could be a potential enhancement of that market into the [unclear] environment. The EIM is a five-minute market. They are also talking about potentially sharing dispatch on a day-ahead basis. The other element we're looking at is creating some price formation or some market mechanisms to actually compensate the providers of capacity, particularly entities like Bonneville that has carbon-free flexible capacity. We're standing ready to help the market meet its ramping and flexibly requirements. That's also another potential revenue source for Bonneville to continue strengthening our competitive [unclear].

Q: To what extent will BPA have to make new investments to accommodate the challenges and maximize the benefits of joining the imbalanced market?

A: There's a significant investment. I think as I was discussing earlier in referencing our grid modernization initiative, several of the major projects on our grid modernization initiative are designed for EIM preparedness, so we have work on metering and settlements and energy scheduling and outage management. There's a lot of technology infrastructure that we're having to build to get ready to participate in this market place. There's also a process reform and just general human change management to get ready for doing business in a fairly significantly different way. The other thing is that we do not actually own and operate the dams. The dams are owned and operated by the Corps of Engineers

and the Bureau of Reclamation. We also have to work with our federal partners to stay aligned and make sure that technology advancements on their side of the meter are made in accordance to the time lines and budgets and that we get everything ready in time for a successful go-live, so it's a big lift for Bonneville, but we're very focused on it, and I think we're generally excited to be a part of that broader market.

Q: Well, the other question is once this transformation is made, to what extent will it accelerate the deployment of renewables at the customer end and more energy storage and all these new technologies?

A: Yeah, it should unequivocally have a big impact. I think, you know, many of the utilities out here in the West, I think, have really embraced the path towards the clean energy economy. We have been fortunate out here for many, many years, particularly in the Northwest, to have a clean energy economy that's built on this foundation of hydroelectricity, so we enjoyed, you know, one of the cleanest system mixes in the United States, but certainly, out here in the Northwest, I think the broader [unclear] the path towards much bigger renewables, and cleaner technology is going to advance the market, I think, as people see it as a critical piece of management structure to get those kinds of renewable generation numbers on to the grid. I think it's also likely through its pricing mechanism structure to be quite useful in enabling new technology, battery storage technology and also hopefully unleashing even more flexibility and capacity out of the demand side. There's a lot of capability in the load side of the equation that we've just really started, particularly up in this region in unleashing a lot of the demand-side flexibility, so that will be another part of it.

Q: I'm curious, as being a federal entity, do you have an easy pathway to calling on the federal labs to research new technologies as it applies to the grid? If so, what are you showing and demonstrating on the Bonneville's-- BPA is 15,000 miles. That might be harbingers of change to come to the grid elsewhere in the United States.

A: No, that's a great question. We've done a lot of work over the years, particularly with the Pacific Northwest National Laboratory. Several years ago, we did a very ambitious smart grid demonstration project that was administrated by Battelle. It was a very, very interesting sort of look into a variety of different demand site technologies. We've also collaborated with the labs on the development of synchrophasers across our systems and instruments that register very finely time stamped measurements of what's actually happening on the grid to help you understand areas where there may be capacity limitations on the system or they help you diagnose problems and anticipate issues, so generally, working with the labs on state-awareness tools and analytics has been very successful for us, and we expect to see much more as artificial intelligence and load

forecasting technology teaches these to evolve in the utility sector.

Q: What are some of the things that you see out there that are really exciting in terms of experiments and capabilities that you're deploying on the grid right now?

A: You know, just in general right now, there's a lot of focus, I think, of trying to get the consumer more engaged in energy decision-making, in making sure that technology that they put in their home can be part of load resource balancing. There's a lot of focus on trying to figure out which combinations of technologies and pricing mechanisms will most effectively customers. It may be in part with the load resource balancing solution. I think obviously as we watch the movement towards much greater vehicle electrification, that's something that has a big impact on our public power customers, and so we're watching that to see how that pattern of load develops on the system and what that means for the distribution grid and potentially for the wholesale bulk transmission system. Then, you know, there's always the element of the known and unknowns, right? I just think back over the last 10 years, just how far the renewable energy technologies have evolved and now seeing the emergence of battery storage. I know there's just so many bright and capable people coming into our sector and so many new market entrants that just the pattern of technology innovation is going to accelerate, and I think there's going to be a lot of opportunity for utilities and others to just help run the grid reliably and affordably and, of course, with a lower carbon footprint. That's very exciting.

Q: If somebody was to twist your arm and ask you to put a percentage on the percent to which your BPA grid is digital versus analog, how would you break that down as of today where we sit?

A: Well, it's a good question. I'm not sure I have a hard answer to that.

Q: How about a soft answer?

A: I will tell you that, you know, our grid modernization effort is taking a lot of infrastructure, much of it developed in the '50s, '60s, '70s, and '80s before the advent of the modern technology and converting it, so we still have quite a bit of work to do here over the next few years to make that conversion.

Q: That's the reason I'm asking that, the extent to which-- if it's half and half, you have a lot of work. If you're three-quarters digital, just ballpark, how far have you come?

A: I'm just going to say I think we're probably, at the end of the day, we're probably on the north side of 50%, but we have a lot of work to do still, so I don't think I've ever had that question framed exactly like that, but certainly, you know, just this year we updated our automatic generation control system which one of the most important pieces of technology infrastructure that allows the system to respond to momentary fluctuations of the system. Those enhancements have already brought greater efficiency where we've invested in

technology that allows us to carry reserves on the hydro system in a much more granular and effect manner, so those are the places that we're focusing-- right in the heart of system operations and grid infrastructure. We're going to keep our head down until the job is finished. There will always be a certain element of evolution. Technology is constantly evolving, so part of it will be to stay up on the curve and continue to drive industry change.

Q: In some parts of the electric grid-- and I'm thinking of a specific project on the East coast, as the grid has gotten smarter, it's enabled utility and grid owners to avoid making capital investments that they would have had to make in the past. There have been cases where you've contemplated some fairly expensive power line construction projects that you've been able to dial back. Can you talk a little bit about that and how the new technology is helping you in that way?

A: Yeah, that's a great question. So, just a few years ago, we were facing increasing amounts of transmission congestion in the Interstate 5 corridor, sort of through Seattle and Portland. For many years, we have had, on the books, a potential new transmission build that we had been planning for. A few years ago, we sort of really dusted that off and said, hey, is it actually time to build this line? We did a lot of permitting. We did a lot of work with communities. The reality was the cost of the line of escalating very [unclear], there was a lot of resistance to building lines that would go through some relatively populated areas, and we basically asked if there was an alternative way to manage the congestion of this line, of this path. Is there effectively a non-wired solution? But we can embrace it and send our transmission engineers and planners back to the drawing board. They came back with a suite of tools-- everything from taking a look at our risk curves in terms of how we quantify the amount of transmission capacity, looking at our state awareness tools where we can constantly monitor in real time what the congestion was on the path. They looked at the commercial products and services to see if we were doing anything to exacerbate the congestion problems. We also worked with the California ISO to use some of the generation flexibility in the energy imbalance market to help pull power out from California up into the Northwest when otherwise we would have transmission congestion. We concluded that we had a deep enough portfolio of alternative approaches that we would not have to build that line which at that point was almost a billion five and climbing. That was a pretty good success story of a non-wired transmission solution. [unclear] who decided to take on the local responsibility of building a local transmission line, and then we sent capacity back to it. In that case, the line was actually built, but we were not the entity that built or the one that had to deploy capital, and I think in other places we're still convinced there's going to be a need for physical, high-voltage transmission expansion in this region, and we're taking a look at that [unclear] on the east side of our system, and for

other utilities, there will be other lines that I think will be necessary both to import, export resources between regions and to enhance the connectivity across the West so that the markets can operate as efficiently as possible.

Q: In summing up as we conclude here, if you had to describe the state of the grid evolution on the Bonneville system as you sit there today, what kinds of words would you use?

A: I would say I guess the first word that comes to my mind is committed. You know, we are very focused on modernizing the Bonneville transmission grid to make sure that you can both leverage and enable the next wave of industry change. I would say we're focusing a lot on anticipating and trying to visualize what that next wave of generation development will look like so that we can accommodate it, make sure that ourselves and others have the necessary grid infrastructure to get it on the system and maintain reliability and make sure that we have enough research adequacy in this region, particularly with the big policy changes. Then, I think ultimately it comes down to collaboration. You know, I think we're all realizing here in the western United States that we're not going to be able to achieve the kind of objectives that we have for the future of our power system without really sitting down and working with each other, looking for ways to share resources, looking for ways to hold each other accountable, for showing up sufficiently and reliability and, at the same time, looking for ways to keep costs as low as possible and run the grid as efficiently as possible, so I think those 3 elements probably are the first to come to mind.

Q: Great, great. Thanks, all, for listening to Grid Talk. Thanks to our guest Elliot Mainzer for sharing his insights about changes in the industry as well as clearly in his BPA region in the Pacific Northwest. You can send feedback or questions to us at GridTalk@NREL.gov. We encourage you to give the podcast a rating or review on your favorite podcast platform. For more information and to get a list of upcoming podcasts, please visit SmartGrid.gov. Have a nice day.

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