

**MARTY ROSENBERG**

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**DREW MURPHY INTERVIEW**

Q: Hi, and welcome to Grid Talk. Today, we're very pleased to have with us Drew Murphy, Senior Vice President for Strategy and Corporate Development at Edison International. We're going to be talking about a wide variety of topics that all center on a very ambitious plan to get to carbon neutrality in their service territory by 2045. Drew, first, greetings.

A: Thanks, Marty. Thanks for having me on.

Q: Drew, we'd like you to start by just addressing the existential moment you find yourself in having undergone wildfire seasons of unprecedented savagery in the last few years along with other utilities in your state, a rampant raging pandemic even as we speak, and a major shift in focus with this pathway 2045 which will be the heart of our conversation. How do you juggle those 3 incredibly challenging assignments?

A: Yeah, well, thanks for that, Marty. You know, not to make light of it at all, but you know, I moved back to California a little over 5 years ago when I started working for Edison. To just put all that in context, at the time,

we were in the middle of a significant drought here, so since I have moved here, we've had the drought; we've had significant wildfires as you mentioned; we've had flooding and now this pandemic, so I do feel like we've had a lot thrown at us as a state and as a society. When I tell you it's been really heartening to me to see, as a company and as an industry here in California, that we, I think in general, have risen to the challenge and really realized that the electric industry and companies like Edison play a really significant role in actually making society work and getting us through this time, so we'll come back to that maybe as we talk about sort of this moment in time and how I think about that when I relates to our longer-term strategy. The longer-term strategy still is as important as ever to us as a company at addressing the need for clean energy and the need to address client change. It's just as important to the state, and frankly, more broadly than that, this pandemic we're experiencing, the situation we've been in with, you mentioned wildfires and the other types of things, just show us that the kind of volatility that we're experiencing now is something we have to be able to respond to and be resilient to get through. That's the focus really of our longer-term strategy is to build a

resilient grid that can provide more and more of the energy that fuels that economy and the society that we live in here.

Q: So, let's dive right into Pathway 2045. When it did it kick off, and what are some of the high-level achievables that you're going to try to accomplish here?

A: Yeah, to give you some background, several years ago, about 4-5 years ago, the state enacted some policies that were focused on reduction of greenhouse gas emissions and put in place a law that said we had to get to 60% reduction from the 1990 levels by 2030, and then with a target beyond that-- I'm sorry, 40% reductions by 2030, excuse me, and then 80% reduction of greenhouse gas emissions by 2050. That was sort of the initial framework for our thinking back in 2017, '16 and '17. We put out an initial energy pathway paper then that tried to take a look at what we thought was the most feasible and least cost-- and most economic way for the state to get there. We did that as sort of across the economy, both the electric sector and the other sector of the economy. What became clear to us at the time back in 2017 was that using the electric grid to help drive decarbonization was going to be the most feasible and the most economic way to do it, certainly in

California, and we think in other places as well as other studies have proven that instance. That was sort of the first marker we put out there which was this view that we needed to have an electric-led clean energy pathway for the state and for our company to try to meet those ambitious decarbonization goals of 40% by 2030 and 80% by 2050. Subsequently, the state has put in place some other policy goals including the very ambitious goal of getting to carbon neutral by 2045, and for us in the energy sector and the electric sector, that means delivering 100% carbon-free energy to our customers at the retail level by 2045. What we did last year was take our original pathway paper to 2030 and extended it out to 2045 and said, okay, let's assume we're already on the path to 2030; what does that pathway look like to 2045? It was really a lot of the same and even more of the same kind of things with higher levels of obviously renewable energy, much, much higher levels of electrification, especially in the transportation space but also in the building space.

Q: Drew, if I can interject, just so our listeners could understand-- getting to 100% of your generation being carbon-free-- what does that compare to where you sit today?

A: We have, we're at just about 40% of our energy today being either renewable RPS-qualified or hydro that is carbon-free. We're in good shape in terms of the electric sector along that pathway. Still a lot to do. What we're anticipating for the electric sector by 2045 is that we'll be obviously largely renewables and storage, a significant amount more of solar and wind, probably mostly solar or about an additional 80 gigawatts of solar for instance, and then a fair amount of storage, but behind the meter and on the grid, up to 30 gigawatts is what our pathway 2045 paper says.

Q: One of the footnotes, I believe, is to get to that 80 gigawatts of solar you're going to have half of your homes and I assume buildings equipped with solar generation. Is that right?

A: Yeah, again, the modeling shows we need about 50% of single-family homes with solar on them and probably some form of storage on a number of those as well. That does not look necessarily at commercial solar. We would expect there would be a fair amount of that as well, but that certainly is the number on the single-family homes, Marty. We're also looking at a significant-- go ahead.

Q: I was going to say, again, how does that compare to today?

How much of a lift would it be to get half of your homes equipped with solar?

A: Yeah, so we're obviously a ways away from that in terms of our own service territory. While, you know, California is probably ahead of other places in the US, I don't remember exactly where we were as I last checked at probably the end of last year, but we've probably, you know, we've got to more than triple the amount that we have currently deployed to get to that kind of the number. The other thing I was going to mention, you know, that has gotten a fair amount of attention is that this kind of transformation of the electric sector is going to also have an impact on other parts of the economy as well. We expect that a lot more uses will be made by electricity to fuel other parts of the economy. Transportation, which I think I was mentioning just a little while ago, and people are talking a lot about now-- we will need to electrify nearly three-quarters of the light-duty fleet by 2045. That's about 26 million vehicles based on where we think things are as of today. We'll also have to do a fair amount of electrification of having the medium-duty sector, so trucks, vans, that kind of thing, busses-- we're already starting to see the transit bus sector electrify significantly, but we will

have to obviously accelerate electrification in the trucking area which doesn't exist at scale yet today. About two-thirds of medium-duty vehicles and about one-third of heavy-duty vehicles is what our modeling shows by 2045 would have to be electrified. Finally, building and space heating in California, where a lot of that is done with natural gas, as it in other parts of the country, a lot of that is going to have to be electrified as well, up to 70% which will mean there will be an impact on the use of natural gas, certainly, in the state, and this is something that has a lot of people, you know, there's a lot of attention on that and what that means for the natural gas industry. We still think there will be a role for natural gas and gas in our economy. Likely, we will have a significant reduction, up to 50% less natural gas usage in the state of California. A lot of that usage will have to switch from natural gas to what we were calling renewable natural gas, you know, bio-methane or potentially hydrogen.

Q: Now, we get to the sweet spot of our conversation and why I'm very pleased to have you with us today given your portfolio for strategy and corporate development. Edison International is a business that has over 12.5 billion dollars in revenues. You have these major challenges now,

mandates from the state and mandates to come on how to harden and boost the resiliency in the face of climate-change-caused fires that have ravaged various parts of the state including yours. Now, you have this pandemic which has got to have a major impact on your revenues as use of electricity, at least for these weeks has plummeted. Given the fact that utilities have always been known as expert in how to drive capital formation, how costly is all these things we've been talking about in the opening few minutes here (boosting solar, building reliance on electricity, transforming transportation). Edison International's role in this as a business faces considerable challenges in its market. How are you going to pull it all off?

A: Well, there's a lot in that question, Marty. Let me first sort of start by saying that the other lens we used for all of this and certainly for looking at what our strategies should be and how we're going to meet these really ambitious goals-- we always bring the lens of, I guess, the double lens of how to make sure that we do that while making sure the grid is safe: safe for our customers, safe for the public, safe for our employees who work on it, and that we do our best to make sure the power that we deliver and the grid that we are building and operating is done so

in a way that's affordable for all of our customers, and we provide electricity to 15 million residents in our service territory, and they are all across the economic spectrum, so affordability is hugely important to us. Add on top of that, which you touched on the importance of making sure that our grid is built and can be operated and relied on a way that is resilient and is hardened so that it survives some of these weather-type events and can withstand the kinds of climate change that we expect to happen as well as making sure that it is de-risked so that it is not likely to be involved in causing any of these events in triggering wildfires or anything else. That's a huge focus for us. That aspect is something that is top of the list in terms of priorities. We actually think that what we-- when you look at all of that, to your point, there's tremendous opportunity for us to play a role in both making sure that that grid is built in a way that's reliable and safe and affordable, but also in investing in new technologies that will make sure that we can actually meet those ambitious 2045 goals in a way that is most economic and most feasible and is most efficient. That's going to help drive affordability as well. I mean, we've done some initial look at sort of the overall cost to, you know, customers

when you get out towards 2045. We actually believe that as we electrify more and more of the economy, transportation, more buildings, because of the inherent efficiency in electrification as opposed to relying on combustion to produce energy, certainly in California but in other places as well, and as efficiency gets even higher of electric technologies, we're going to see that it will be more affordable for people to use electricity to fuel more and more of their lives. That's something that we put right front and center in how we think about this.

Q: I'm just going to ask you to focus on Edison International and SCE as its business. There has been a lot of talk about stimulus funds and the federal government, and they're quickly going up to talk about trillions of dollars. Your company and its subsidiary serve an excess of 15 million residents in and very densely-populated part of our country. Will it take trillions of dollars of investment on your behalf to make this transformation possible by 2045?

A: It's going to take investment across the economy both through the utilities like SCE and the other utilities in the state, but there are lots of other actors. Our high-level estimate, I think, is about 170 billion dollars of

clean energy investment that we think will need to be made across the state to get to 2045 and to build out the level of renewables and storage and frankly the grid technologies to go along with that to make it all happen and to connect it. Let me underscore. That investment, while it is money that has to be raised and paid for, it also represents a huge economic development opportunity for the state. We expect a tremendous number of jobs, especially skilled jobs, construction jobs, research jobs to be tied to that and other potential funding for infrastructure and research, that kind of thing. I think it's a terrific opportunity for investment and for economic development in the state as look at it. It's not just us. It's going to be lots of other folks as well.

Q: I understand the big pot we're talking about here, that 175 billion of investments by you and other utilities and other players. Is that right?

A: That's correct, Marty. Yeah, we do everybody from the utilities to the folks that are going to be installing and uprighting the solar plants and not only solar plants but to storage, to charging infrastructure for electric vehicles, and on and on. It's across the economy. One of the areas we have just started to really think about what

it looks like and this is something we're early days in is what does the grid need to look like when you get out to 2040 and 2045, that far out? It will definitely have different aspects than it has today, new technologies, and we're just beginning to put together an approach to saying how can we re-imagine what the grid needs to look like, how it needs to operate, what capabilities does it need to have to deliver on these policies, but also to deliver on the promise we have to our customers that, as you rely on the grid to deliver electricity to power more and more of your life, not just your lights but now your heating and your cooling and your transportation and your internet and your cell phone and all of this, we're planning to be really important in this time of COVID-19. We need to make sure that that grid is efficient, available, reliable, and that it operates consistently across a service territory so that we can provide that fuel for everybody's life on a daily basis. We're really taking it seriously right now and looking at what those new technologies could be.

Q: As you look at how the grid will look differently, I'm sure you're also looking at how your business will look differently. Any thoughts that you can share with us on what the utility of 2045 might look like?

A: You know, I think in some ways it will probably be recognizable and look similar to today. Edison has been around for 130 years and has certainly changed in many ways. Also, the fact that we are tied to the place that we-- and the employees of Edison-- where we work and we all live and we're in our communities, I think that will continue to be very recognizable. The fact that our employees are out doing work in our communities and connecting every home and business in our service territory, that will continue to be the case, and so I think you will recognize many aspects of how we do business in terms of the connection to our customers, the connection to our communities, the fact that we're part of the fabric of the economy in our service territory here in California. What I think will hopefully be quite different is that we may find as a company we're working in different ways. Certainly, we're talking about that right now. We're working from home largely. We perform an essential service. We're a critical infrastructure company, and yet we have moved a well over two-thirds of our employees to working remotely during telework. We have very few people going into an office anymore. Last I heard, frankly several hundred out of 13,000 employees. We obviously have

a number of employees who are out doing field work. When our stay-at-home orders were just about to be issued right before they were in effect, we went-- in 3 days, we moved two-thirds of our work force, over 8,000 people from the office to work from home. That's just a great example to me of how technology and time and necessity can hopefully drive us to be innovative and to look different as a company when we look forward in the years and yet still perform the same service and still have the same role in our community.

Q: Do you think you're going to have trouble getting them all to come back to the office? Is this a permanent transformation?

A: You know, it's certainly a discussion, I think, we're having at our company. I think it's going on a lot of places right now. We're in an interesting moment in time. There are good things about working and not having to go to the office-- certainly in California and Southern California not having to have a long commute which many of us do is a positive thing. Yet, I know there are many folks who miss the interconnection, the connection with people, socializing, the kind of brainstorming that happens when you see people physically. We can do some of that

virtually. I think it will be mixed. I think it will look different, but I hope we get there sooner rather than later, and we will have the choice on how we can come back, but we are trying to learn from it. I will say, you know, we are trying to make sure that we're always doing this with the idea of protecting our employees and looking out for them and our customers first, so we will not come back in a way that puts anybody at risk needlessly, and I know that's on everyone's minds at the moment.

Q: I was going to circle back to some of what we were talking about earlier-- the economic collapse that this pandemic has brought about. How will that affect the roll out of the strategy that you're well into now in terms of addressing pathway 2045?

A: It's a really good and interesting question that we're thinking about, and I don't think anybody knows the answer right now. This is a situation that really involves day-to-day. There's certainly a risk that, if we have a significant recession and economic disruption that lasts for a longer period of time, that could impact the ability of our customers, the businesses in our state, and just generally the economy to support some level of investment that needs to be made to drive us towards those aggressive

climate goals that we've talked about. I am concerned that, you know, people will push back on making those investments in the short term. We want to make sure we do everything we can to try to find ways to continue investing in and pushing in that direction. One of the things we are seeing, for instance, with people not driving to work every day, we can actually see an immediate impact on our air quality. The air is much cleaner, and I know people are experiencing this in other places. That's obviously a short-term impact. If we look at climate change, you cannot see greenhouse gas emissions. We have to make sure we all take that lesson and remember that converting our transportation sector from internal combustion engines to electric transportation will have the same impact on our air quality but also address climate change in the longer term. We have to take a lesson from this time and make sure that it's not lost when we come out. I do think that there's a risk of a recession and then economic downturn. We'll re-prioritize at least for some parts of the state and some people where they are focused and the importance of sustainability and climate change. They won't for us. I will say, for Edison, it will, being a sustainable company, making sure that we are focused on both the

climate change goals but also being sustainable as a business for the long term which is what sustainability really means to us. Back to your earlier question about what we will look like in 25 years-- we plan to be here, and we plan to be an important part of the fabric of society, and we believe our strategy to invest in clean energy technologies is still the best way to ensure that's the role we play and that we actually have a state that is cleaner, more sustainable, and more resilient when we get there, so I'm hopeful that the long-term will be able to get where we need to, but I do think the next couple of years we could experience some headwinds, especially economic headwinds given where we are now.

Q: Drew, I know you travel around a lot to a lot of industry meetings. To what extent do you think these kinds of policies and innovations are unique, that you're company and your state is going to be ahead of the country, and does that give you any pause or concern? There was a period not too long ago, several decades back, where California embraced policies and got ahead of the rest of the industry, and that didn't turn out so well. I realize the importance of these issues being mandated by state policies and law, but do you worry at all about getting

ahead of the industry or is that something that's not on your mind?

A: You know, it's funny, Marty. You have been in this industry and around it for a while and have seen some of the ebb and flow of interest and investment in renewable energy and clean energy, but if I step back and look at the longer-range trend, it has definitely been towards renewable energy, towards addressing climate change. I am an optimist in the sense that I think that we're still on the right path generally. I guess what I would say in terms of California's role in that, and that's EIX's and Edison's and SCE's too-- I've been really amazed to see that even since we put up the first pathway paper in 2017, which was a bit of an outlier at the time in terms of taking a position as an electric utility on how aggressive we would need to be to support these kinds of greenhouse gas reduction goals, we have seen a number of other utilities in the US and abroad, but particularly in the US come in with very similar plans, putting out similar sort of pathway-type papers showing what they think they need to do in terms of de-carbonizing their electricity next, shutting down more coal plants, building more renewables. I tend to see a lot of industry meetings with the other

utilities, and the interest in commitment to transportation electrification in the last 2-3 years has changed significantly. There are working groups in all of the industry groups on transportation electrification, on larger electrification of other parts of the economy, so I actually think, you know, California can lead on this, and we as a company can lead, and that's what we try to do is to sort of take that message that there are ways to think about this that are both achievable and still economic and still can be affordable for your customers, so I think we can lead. We have to always be conscious in California that other places have different dynamics, so we try to make sure that we look at it through their eyes as well. I think the industry is moving generally in a very similar direction. I think we're on the path that others are on as well.

Q: Great. Thanks for talking with us today, Drew.

A: Well, I appreciate it, Marty. Thanks for having me on.

Q: Thanks for listening to Grid Talk. We were talking for the last half hour with Drew Murphy of Edison International, and he is sharing his insights on what's happening at his company and in California and across the industry. You can send feedback or questions to us at [GridTalk@NREL.gov](mailto:GridTalk@NREL.gov). We

encourage you to give the podcast a rating or review on your favorite podcast platform. For more information about this series or to listen in to more than a dozen previous podcasts or to subscribe, you can visit [SmartGrid.gov](http://SmartGrid.gov).

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