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DALIA PATINO-ECHEVERRI INTERVIEW

Hi and welcome to GridTalk. Today we're very pleased to have with us, Dalia Patino-Echeverri, who's associate professor at the Nicholas Institute at Duke University.

Q: Hi, Dalia. How are you today?

A: Hi, Marty, really happy to see you.

Q: We're excited to get into your work but before we do, why don't you give us an overview of what the Nicholas Institute is, what it's objectives are.

A: Actually, I'm a professor at the Nicholas School of the Environment at Duke University; we have the same name but we are different. In the Nicholas School, we have three divisions. One is the Environmental Sciences and Policy Division. Another one is the Earth and Climate Sciences and the third one is the Marine Lab in Beaufort, (NC) and we do all kinds of research related to the environment. We have a very large group of economists, ecologists, toxicologists, hydrologists, geologists, political scientists, very interested in looking at all aspects of environmental protection.

Q: So, you're based in North Carolina and we're going to be talking about some of your work with Duke Energy, specifically how we can be more reliant and deploy more solar and wind energy which are intermittent resources which post risks and creates uncertainty for the market, which you're addressing directly. Tell us about your work on modeling and to just set this up, currently solar represents about 9% of America's net summer's capacity or 4.5/4.7% of the annual generation in America. If we could boost that, which is everybody's goal, certainly solar is a leading new resource in energy production, it will become more valuable so tell us about the reserves that are now required for solar and wind and how you think we can finetune that and make progress on that front?

A: Thank you Marty. Yes, well our work looks to continue to achieve big challenges that we see in the electricity industry and in operations of the power generation fleet that we have. And it always starts with, what is the most critical function of an electric power system operator? It is to keep electricity generation/production with consumption (demand or load) in balance, in perfect balance, at all times. And this delicate balancing act between generation and load requires very, very careful planning. So, ahead of time, the system operators have to consider first, the forecast of the electricity demand, and then they have to consider the forecast of all the electricity generation from wind and solar resources. And they also have to keep in mind the changing availability of the conventional resources like coal fired power plants, natural gas plants, nuclear plants, because the availability also changes with the fuel supply availability and with the weather. And keeping all of these forecasts of demand, of wind and solar, and how much of the traditional conventional power generation is in mind, the operators have to schedule the operation of the whole fleet. And this schedule is done so that it minimizes the expected costs of meeting demand, right, the expected costs of operating all the system assets; the generators and the storage devices, etc. So, this process of balancing the forecast of the load and the estimates of the renewables production and the conventional resources of schedules is a mathematical problem that is solved by computers every day and many times a day as well and sometimes many times within an hour as well. And, the solution of these mathematical problem, what it does is it specifies the schedule of every single power plant, and within the power plant, every single generating unit within the power plant. So, it tells you when to start that power plant and that unit within the power plant and when to shut it down and how much of the capacity to keep as reserves.

Q: So, as we get to a more distributed grid, there are more end points; this gets increasingly complicated, does it not?

A: Absolutely. So right now, I haven’t mentioned anything about distributed but there are a few things here. One is that the error in forecasting the load, how much people are going to consume is exacerbated as people are starting installing new things that we haven’t had collected data for so, for example, as people electrify their homes and stop using or use less natural gas and use more electricity as they use less gasoline and more electricity to power their cars, and as they generate their own electricity. So, now we have to forecast the net load; what is their demand but after subtracting all the electricity that they can generate at their homes. That would be like behind the meter generation and consumption. And then we also have community solar facilities; smaller facilities and we need to integrate a forecast of how much they can produce into a system to keep demand and supply in balance, so what I was saying is that you have this plan that you are going to start plants at this hour and shut them down and produce a set megawatt number from each unit but you know you’re going to be wrong because if you follow exactly that plan because what are you accounted for at the forecast of demand or whatever you said is going to be the production of wind or solar energy is going to be wrong because we cannot project precisely or perfectly forecast those things, so we keep reserves. We say we're going to keep the power plants at a point where if we need to increase capacity generation, we increase it, and if we need to decrease it, we decrease it. And that requirement for reserves for this flexibility in the power plants, it grows with the penetration of solar and wind. You need more and more of these reserves to react to these greater forecast errors to create uncertainty that you have on how much it's going to be, so…

Q: So, all things being equal as we go to intermittent renewal resources increasingly, there's more uncertainty if we do nothing else, there will be the need for more reserves will there not?

A: Right, so we will need more…

Q: You're addressing that so tell us how you're addressing that.

A: Yes. So, we're going to need to have resources that can provide reserves, right, so resources that are flexible enough to ramp up the electricity production or ramp down the electricity production as needed. As you go on and find that you need to react to sudden decreases in solar production or increases in solar production or wind so we say well rather than pursuing a target of reserves, like saying I need to have these reserves for the next hour because I think that my error is going to X or Y, which is what is done today, and we have and we say this is my forecast of load and this is my forecast of solar, this is my forecast of wind, and I plan for that and I keep some reserves in case I'm wrong. We say, well, consider all the scenarios that are possible. Put probabilities into those scenarios and then let your mathematical model decide when you need reserves and how much varying with the uncertainty that you have under those scenarios, what is possible. And those scenarios come from the weather, from the weather forecasts. The weather forecast affects load and it also affects the production from solar and wind resources. So, we say consider all possible weather futures for tomorrow; all the possible variables in temperatures and humidity levels, solar radiation, wind speeds that we can have; will it be sunny tomorrow…

Q: When you say tomorrow, you mean literally tomorrow?

A: Yes.

Q: So, we're sitting here today and under this model, will you be looking at tomorrow and every day you will stay a day ahead?

A: Exactly, yes.

Q: Okay, go ahead.

A: And we say, well, in some cases we have to look at, let’s look at all the possibilities for the weather tomorrow but also the day after tomorrow and several days because there are some plans we have to…for some plans, we have to plan ahead or resources, we have to plan ahead maybe a week ahead, like for example, one system that we’re looking at is here in North Carolina; we are looking at the Duke Energy Carolina / Duke Energy Progress System. It is an interesting system because itself alone, it provides more than 7% of the solar generation of this country. It’s very interesting; it has 6 gigawatts of solar capacity which is about 7% of the solar installed capacity in the United States. And it’s very interesting because it has pumped hydro storage; it has two gigawatts of pumped hydro storage. So, these resource makes us…forces us to plan ahead, one week ahead. Because another point we have is we have nuclear as half of this system. So half of the generation from the system comes from nuclear power plants, which are not flexible. You know you can know the challenge of shutting down nuclear plants when there is a lot of solar and then say, oh well, I can just start my nuclear plant later when it is at night. You start your nuclear power plant and you want to keep it online and a very high production level because that is what reduces the cost of electricity from this plant. So, in this system with a lot of solar, with a lot of electricity from nuclear and more than 50% of it, and with a very large pumped hydro storage system, we have to look the day before but we also have to have a horizon of whole week to plan what we're going to do with this power plant and with these storage resources so that we balance them in the supply in the best way. That means, we don't have to shut down and start up coal and natural gas plants all the time because the start-ups are expensive. We have to burn more fuel than if we just keep them operating online. We also don't have to curtail or spill renewable energy. We don't have to waste it; we can use it all. We don't have to increase the generation of expensive resources like combustion turbines, natural gas turbines which burn a lot of natural gas per electricity generated because we are always looking at the possibilities of the future and planning for all of these uncertainties and keeping our system in the most flexible position to increase up and down in the most economical way.

Q: So, talk a little bit about what role computerization, artificial intelligence is playing. Do you have newly; are you on the horizon of new capabilities that were not operational 2, 5, 10 years ago in the industry?

A: Right, so what we are proposing is using a technique that is stochastic optimization instead of deterministic optimization. So deterministic is: "I know what all the cost are and I am taking the best position in this cost”. Stochastic says that I know things are uncertain and there are going to be some surprises so I am going to account for those possible surprises with the probabilities and this approach has been proposed for a long time but it has been difficult to implement because you needed large computational resources to get answers in time to run your power system, right, so when you see a storm coming, you need to decide what you are going to do with your power plants but in less than an hour you should have an answer so that you can notify all of the operators at the power plant that you may need to start up or shut down or increase their production capacity, etc. And with artificial intelligence and with machine learning, we have found ways to run these models that are more sophisticated, more demanding of computational resources. We have found to simplify those requirements and we have found ways to run them faster.

Q: So, would you consider this a test phase or is it actually being deployed and used on a regular basis now within the Duke system?

A: No, this is under development and we want to have a pilot in the next year or two years. We are proposing different ways to implement it so one of them would be without changing anything of what is in current use except by giving some input, some numbers into the systems that are currently in use so we can run all of our models in the background and ahead of time and get some input numbers that can be used in the system that we have available today so that the integration and the deployment of these technologies is simpler and it can be implemented now. Now, there is a more effective implementation that would require more modifications of the systems that the utilities have today and the operators have today.

Q: So, talk for a second because in your bio it says that you have a particular emphasis in your work on managing the risks arising from uncertainties influencing the outcomes of government actions. Tell us what the real-world consequences of this work might be. Will it allow for faster deployment of renewables? Would it allow greater penetration of intermittent renewables like solar and wind? By whittling down the reserve margins, will that lower costs and mean that all of this is less expensive? Talk about some of the ramifications of the real-world consequences?

A: Right, yes, thank you. Yes, the number one benefit that we see in our technology is that we're going to have the right level of reserves at each moment and in time in our system and…

Q: So, why is that a big deal for economics?

A: It is a big deal because if you have very high reserves, your system is very safe but is very expensive and when you have an expensive system, you pose risk on people, the people who consume the electricity. And we have seen in the country how people make tradeoffs between electricity consumption and things like paying for healthcare or food or education. So having a safe electricity system that is wasteful is not safe. It poses risk on all of us so we don’t want this reserve to be really high. We don’t want them to be really low because if we have low reserves and there is an unexpected event we can have outages. We can have expensive operations if we are lucky, just expensive operations. We just start up whatever we can and waste fuel to match the load but in the worst case we may not have that luxury and we may need to have outages and maybe even blackouts.

Q: So, you’ve clearly addressed the financial aspects of this. What about the other piece of this which I have said is that solar today is about 4½% of the generation of 2022 but in that year, it also represented 46% of the new generation capacity that was deployed. Will the kind of technology you’re working on allow for even more ramp-up of solar and wind?

A: Absolutely. We will be in a better position to integrate the valuable renewable energy that we get from solar and from wind because we will be considering all the possibilities and we’ll be prepositioning our system in the best way to cope with the varibility and the uncertainty of these resources. And we will… the thing is, we will not have to spill or to curtail this energy as much because we will be able to do what is needed on our storage systems and on our conventional natural gas power plants to make room for these resources. And as these resources are dispatched more often, they are less curtailed for example which is the idea. If they are less curtailed then their cost decreases, right? Their cost of their electricity produced decreases because their capital costs are spread out over more kilowatt hours that they produce. And this is a better deal for the investors because you know you're going to be getting the most of your solar/wind investment so this also reduces costs and there's more deployment.

Q: So, let me ask you a philosophical question if I can.

A: Yes.

Q: Which is for years the electric utility industry has been criticized. I heard Bill Gates and other people say, as the percentage of money the electric utility sectors spends on R&D is among the smallest of any major sector in our economy. I think he jokingly said that the petfood industry spends more on research as a percentage than utilities. Are organizations like EPRI working on the problems you're working on? Is Duke investing money in your work? Who's funding this work? What kind of federal resources do you have to apply to these important problems?

A: Yeah, good question. This work, especially this work by ARPA-E by the PERFORM Program, the program that seeks to think about risk and uncertainty in operations in the electricity sector. It looks at what is the risk that each type of technology brings to the power system, the electric power market and how can the compensation that we give to the investors be commensurate with that risk? So, yes, ARPA-E is funding my project and all of my projects along this way. ARPA-E along with the Department of Energy and EPRI just recently had a competition on who could forecast net load the best. And the goal of the competition was to invite people to think probabilistically about forecasts: so don't say your forecast is this, that you expect that this is going to be the value for tomorrow. Instead, say what are all the possible values that are plausible for tomorrow and what are the probabilities? We participated in these along with other teams and…

A: I imagine you cleaned up and you do.

Q: We were…they kept changing the date for the start-up and we went on vacation so we didn't do as well as we wanted to but in the last week, we did great which is because when we could deploy our full technology, which showed us the best way to go. That you have to look at the weather forecast and consider the uncertainty in your weather forecast and then just let the uncertainty of your weather forecast tell you about the uncertainty on the forecast of load and the forecast of wind and solar. With that, you can plan much better.

A: So, Dalia, the last question I want to ask you is as somebody on the frontline of this battle that is ready to deploy some tests within the Duke system, how soon do you think this approach if successful will be out there making a difference for utilities around the nation and possibly around the world?

A: I expect not less than two years.

Q: Really?

A: One to two years. There are already important developments. The uncertainty, the embracement of uncertainty is increasing day-by-day because that's what solar and wind are posing ahead in front of us. And we are coming with better ways to capitalize on that uncertainty and hedge against it.

Q: Okay. Is there any last words you want to talk about what it feels like to be doing this work?

A: It's very exciting. I have a great team of postdocs and Ph.D. students from all continents and it's remarkable to see that a lot of young people are interested in these challenges. If we care about the environment, we have to care about energy and this is a great place to start. And the electricity industry is investing more and more so the numbers you were citing from Bill Gates, I would like to think that's from the past. We are now in a new moment where there is investment in all sorts of alternatives for solving this conundrum including software alternatives like what we are doing. And these technologies of how to plan and operate and analyze data and use new computational resources for these.

Q: Okay. Thank you, Dalia.

A: Thank you, Marty. It was a pleasure.

We've been talking to Dalia Patino-Echeverri, associate professor at and I stand corrected, at the Duke Nicholas School of the Environment. Q: Did I get that right?

A: Perfect.

Q: Have a great day.

A: You, too. Thank you so much.

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