MARTY ROSENBERG
MARCH 9, 2021
GT #209
DR. KEN MEDLOCK INTERVIEW

Q: Hi, and welcome to Grid Talk. Today we have with us Ken Medlock, who's the Senior Director of the Center for Energy Studies at Rice University's Baker's Institute for Public Policy down in Texas. Hi, Ken.

A: How you doing, Marty?

Q: Thank you for joining with us today; I'm doing great. We really would like your perspective on what happened, what exactly happened to Texas and its grid the middle of February. Why don't you just start telling us where you were when it happened and what kinds of thoughts went through your head.

A: Sure. I actually, believe it or not, I've lived in Texas for a long time so I was – I grew up here, and as they were forecasting the cold to come in, I actually had conversations with my students – cohort graduate students and masters in Ph.D. students that I'm teaching this semester – on the Friday prior, and had a conversation with my wife about this, too, just recalling the events of 1989, believe it or not, when I remember very distinctly, a cold blast that was almost on par with what we just experienced, moving through the Houston area and waking

up at about three or four a.m. in the morning and hearing; it just sounded like gunshots going off through the neighborhood. And it was because on the north faces of all the pine trees because of the wintery precipitation, they all froze and started to snap and break off. And, it was devastating actually to see what happened as a result of that. I mean, there was a lot of transmission lines that were down cause these branches were falling on transmission lines and of course, there were a lot of broken pipes and all kinds of things, but to be honest with you, I don't recall the power outages being as bad as they were this time around, and that may have to do with a number of things, but I know there were some outages, but those conversations I didn't think would be as good as predicting as what was about to happen as they were.

Q: So, what happened was that 356 generators went off-line.

A: Yep.

Q: Millions of folks were in the dark for up to four days; five million homes and businesses, four days. That compares with the last epic blast more recent than you're recounting…

A: Yeah; February of 2011, yeah.

Q: In 2011 power was out seven and one-half hours.

A: Right.

Q: This time, it was on average 70.5 hours; ten-fold more damaging outage. What went wrong with those 356 generating stations?

A: You know, that's a great question and having lived through it, it's one that I what to know with very specific details, know the answers to. You started to hear about the wind generators going offline because they were freezing up. That was the first thing that kind of hit the news wire if you will, and loosely using news talking about Twitter, right, and living through the middle of this freeze, I had intermittent cell access, too, so I was kind of getting it – living it in real time and getting it – updates every couple of hours so to speak, but we were without power from late Sunday night until late Wednesday night so we were without power for a long time and, of course, about twelve or so hours into that, the water pressure starts to drop so didn't have that either for about five days. It was hellish and one of the things that, of course, given my role here at the Baker Institute that I and all the folks who work with me are and still want to know and are digging into is exactly what happened, where, and why.

Q: So, Ken, this would be a good point of saying, what is the role of your central interview phase in Texas and what mission do you think you'll be taking on to study this outage?

A: Yeah, yeah, that's actually where I'm going so it's no problem. So, given my role here at the Baker Institute for Public Policy at Rice, we engage with a variety of stakeholders from practitioners in the industry to NGOs to policy makers and regulators on various issues in the energy environment spectrum. And so, of course, what just happened in Texas fits squarely in that space and we have begun to really try to take a more micro-oriented view of what happened on the grid here in Texas because there's a lot of high-level data that's been sort of floated just in terms of the raw numbers of facilities that were out with some speculation as to whether or not facilities themselves froze or they lacked access to supply. You can think about all the different things that have been stated. Until you actually start to do a little bit of mapping, and we've started to do some of this work to figure out where, for example, natural gas facilities sit in the Texas energy eco system. These generating stations are largely along intrastate pipeline systems and so they rely on gas supplies to move from the wellhead through processing onto those systems and to the facility so they can be combusted turned into power and typically that works just fine. But we know that a large fraction of the gas gen fleet in Texas was inoperable. ERCOT actually released information on Friday, March 4 I guess it was, or on Thursday, yeah, on March 4 about

which stations were out; which generating plants were out but there's no detail why. It's a very comprehensive list about when facilities were derated in terms of the times they went off; they do it by generating unit within the station so it's very detailed.

Q: Isn't there going to be any one entity that's going to be charged with doing the forensics on this? Is it going to be ERCOT? Is it going to be the PUC? Will the legislature be doing it or is there going to be a dozen?

A: Yeah, there's already hearings on this, right, and PUC is taking it up. ERCOT is, of course, taking it up. I think there's going to be multiple, multiple sources of information that do their own sort of forensic analysis of what exactly happened. That's actually one of the things that we're doing because like I said, trying to understand what drove failure of the grid because it was a failure on almost every front, right? You know like I said earlier, the initial discussions was about wind being out but that was, that was not what happened, right? This was not a wind issue.

Q: You're getting right now to the heart of why I really wanted to have you online for this conversation and that is, you teach economics at Rice. You have, I believe, a Ph.D. in economics?

A: Yes.

Q: What is wrong with the business model in Texas and I realize you may want to give us a thesis now that you test out by doing a lot of research.

A: Yes.

Q: But something in this system does not incent hardening the generation and transmission grid. Can you opine on that a little bit?

A: Yeah, absolutely. That's actually where I'm going, believe it or not so…

Q: We're on the same track.

A: Yeah, absolutely. So, as I said, this is not a wind issue, right? This is an issue of the entire energy ecosystem failing. And generally, when something is catastrophic as what you just saw in Texas happen, I mean, you've seen the reports minutes away from catastrophic failure of the grid, right? and to be fair, the grid manager, ERCOT…

Q: Specifically: four minutes and thirty-seven seconds?

A: Yeah, exactly.

Q: How did they come up with that?

A: Well, they're looking at the frequency variation, right? You typically want to be right around 60 hertz and they dipped down into the 54 hertz range, I think, and so…

Q: If that were four minutes and thirty-seven seconds hadn't been breached the potential for the outage would have been for weeks if not for longer. Is that correct?

A: That is correct. Yeah, it could have been, I mean, it could have been a few days to several weeks. It really just depends on the extent of the damage on the system as a result of violating that, that allowed frequency variation.

Q: Okay, so get back to your economics analysis, please.

A: Yeah, no problem. So, just to finish that thought. ERCOT did what I would say was an admirable job of keeping the system from failing at a time of crisis, but everything that got us to that point was an absolute failure. So, that's really where you have to begin, alright, what drove it? And, there's a number of things and this is actually where a deeper analysis is warranted which is why we're looking at this in a much more rigorous way, but when you think about one of the things that's been talked about a lot is winterization so hardening of the infrastructure because there's a lot of discussion about things freezing up and you think about the incentives that exist in what has been classically termed as the energy-only market, which is what ERCOT is. It really is about generating power to sell into a wholesale market that presumably is going to provide a return to capacity that capacity investments have been made. Now, usually

if you're at the bottom of the supply stacks so you're the low-cost generator, you're going to be in a better position to earn returns when demand rises because additional generation resources will be called upon, right, and that means that you're selling your price at above what it costs you to generate, so that's when you get a return. Well, that has incented a tremendous amount of what you might call a race to the bottom in terms of costs. Everybody's trying to be the low-cost generator and when you look at the Texas grid in general, that means the incentives are aligned to be sure you're operable during peak demand periods which is usually the summertime in Texas. Now, we had four days of subzero temperatures. I think there were 108 hours of below-freezing temps in Dallas. Well, the energy delivery system is not designed to withstand that, and we saw that really reveal itself remarkably and you might ask yourself the question, "Well, why isn't it?" Well, because if you think about it from the standpoint as an owner of an asset and you look at the frequency of these types of events, if they only happen four days out of every, say twenty or thirty years, and it's a race to the bottom to be the low-cost energy provider. If there is no mandatory obligation to winterize your equipment to deal with those four days out of every twenty of thirty years, then it's highly unlikely a generator or a power provider or any

infrastructure owner is going to incur the cost associated with that because the cost benefit doesn't bear out.

Q: Why is it that nobody came up with that analysis in 2011 or earlier or why…?

A: They did.

Q: Or why has a decade come…

A: They did and this is what's remarkable about it because 2011 should have been a warning shot, right, because it got really cold. It wasn't as bad as what we've just lived through but it got really cold; we had some generation outages. You had freeze-offs at wellheads out in West Texas and the Permian Basin, I mean, all of these things that you're hearing about happening that just happened in mid-February, happened back then. It should have been a warning shot. There was a study done that looked at what happened and there were suggestions/ recommendations made that winterization was necessary. Well, when those recommendations were made, there was no obligation that accompanied them or no penalty for not meeting those recommendations. And so, of course, it was like, okay; duly noted and you just could of keep moving along, business as usual. Now, there were some facilities that did take those on board. You probably heard about them like in Beaumont and El Paso and so it wasn't like a blanket, nobody did it, right. But

there was no mandate. There was no obligation. There was no regulatory intervention that said everybody needs to be in compliance with some minimum standard.

Q: In your mind, Ken, who should have been doing that? Should it have been the PUC? Should it have been ERCOT? Should it have been the legislature?

A: I think ultimately it comes down to something that's administered through the legislature, through the legislative process but and there's actually interestingly now…

Q: Let's open one more can of worms and that is, I had Bill Magness on actually in January and I talked to him about ERCOT being an island unto itself and if there was any appetite or any rationale to better interconnect with the grid across North America, and he said, "Nobody in Texas really wants that."

A: Ken laughs.

Q: Do you think it's time to re-examine that? Do you think ERCOT should not be unto itself and which case, FERC would be making some of these requirements, would it not?

A: FERC would, they would be, yes, so that's actually one of the biggest drivers behind why ERCOT has remained an island, right. It's effectively avoidance of federal oversight. I don't think that and I haven't – by the way I haven't – I've had this position for a while. I don't think that the cost benefit bears

that out. Land is relatively inexpensive in Texas. It's easy to site new infrastructure. Tremendous natural gas resources. Tremendous wind resources. Very nice solar resources. In sum, if Texas were connected, it would be a massive exporter of power on any given day to the rest of the country. There's a value proposition there, right?

Q: Is that bad?

A: No, it's great! As a matter of fact, it actually creates jobs locally. It creates an economic opportunity that is effectively going unrealized because there is a barrier to trade. So, this is a position I've had for a long time.

Q: Ken, if the truth be told, I'm sitting here in Kansas City in the Southwest Power Pool and when Texas was going through its power sizing's around this windstorm, there were rolling outages throughout the region, well beyond ERCOT's boundaries so we paid the price of Texas being islanded. Why can't we benefit from having access to some redundant renewable resources when there's more than Texas needs?

A: I'm not arguing; that's exactly what I'm saying, right? There's an unrealized value proposition associated with not being connected. When you don't have transmission capacity, it's a barrier to trade and so it limits opportunities to access lower cost, abundant resources that exist on one side of that

barrier from the other. And so, I think that the state should be looking very hard at accessing the cost benefit because as far as I can tell, there is no valid argument for Texas not being connected. Now, one thing that we have to be conscious of when we have this conversation is, there are folks who are saying if Texas had been connected during this last storm, it would have benefitted by being able to wield power in and that's actually not quite true, because if you look at the emergency reports on ERCOT they had, they had to have frequency control; they actually had to shut down some of the limited interconnected capability that existed with DC interconnects and so and that's because there were outages on both sides, right? But here's my point, yeah, here's my point: if you go back thirty years and you have viable transmission capacity that connects ERCOT to the Eastern and Western Interconnects more generally, into SPP, into MISO and to the WEC, right; if you have those connections, it changes all of the investments that occur over the last thirty years. It makes those transmission connections more robust. It alters capacity investments on both sides of the connections, and so when you get to what we just went through, arguably, it looks a lot different. And so, when you have a conversation about being interconnected, it's also important to pair that discussion with a discussion about how investments would

matriculate if you were connected. And that's where I think is missing from the discussion.

Q: So, you're getting an exercise in looking backward. How about doing and exercise looking forward? The end of 2020, there's 30,000 megawatts of wind power that's been built into Texas. That's 200-fold increase from just the year 2000, and you're slated to have 38,000 megawatts of wind in three years. Doesn't it make sense to maximize the value of that asset by being more interconnected?

A: Absolutely. I – that is exactly my point. In fact, we, a colleague of mine and I did some work looking at what if you could develop high voltage direct current transmission using nanowires so this was a nano technology discussion. You know, these are very lightweight, high efficiency carbon nanotube structures that are great conductors of electricity. We were looking at exactly what you're asking. What if you could use those very large interconnect capacities to pair, for example, Texas wind with Arizona and California solar. You have non-coincident peaks. You'd be wheeling wind West when the wind's blowing hard and solar East when the wind's not. And it just makes for stability. That's actually what connectivity does; it creates a resilience opportunity that is going unrealized at the moment, so, yes.

Q: Ken, I'll hedge you one; if there's one economic rationality into doing exactly as you just sketched out. The extras value's that generated, the extra wealth's that generated out by that greater efficiency; some of it could be used to harden the assets in Texas for the next time a major wind storm winter storm comes through?

A: Oh, absolutely right, that's absolutely right. Look, in a competitive market, so any – I'll just preface this with, any market is as good as the rules that govern it, right? And, if you're going to have a competitive market, you have to think about ways to cost-in the social cost of reliability, and that is effectively what this conversation is about because if you are not appropriately incentivizing hardening the infrastructure so you can withstand these very cold periods or even a very hot period or a very stormy period as we have on the Gulf Coast, then you actually run the risk of outages and if those outages occur with any duration like we just saw, there's a human element to that, right? There were people that died as a result of the freeze that we just lived through and the inability to generate heat because there was no power so you have these issues that need to be confronted and they need to be costed into the system which means if you have a mandate that says if you're going to operate in this market, you need to meet these

certain minimum standards, everybody would do it and that's what's missing right now.

Q: So, what's you hope as a Texan, knowing how strong the political winds blow through your state, of having this kind of honest assessment or do you see people so dug into preconceptions about the Texas way of independence, that's it's not going – this argument's not going to take place?

A: The argument is taking place, actually. As a matter of fact, there are several House bills that have been introduced already in the state legislature that address some of these issues head-on, effectively addressing mandatory winterization. Addressing resilience of the natural gas delivery and infrastructure, which is something we really haven't talked about very much yet but happy to. Addressing a variety of issues that have come up as a result of this recent winter storm and some of them are kind of fielded policies, wind, political favor. Some of them are much more serious, much more aimed at really trying to address some of the fragilities that were just exposed in the entire grid and that includes even interconnection. So, there's a lot of things that are being discussed in real time in Austin now that weren't prior to this event so hopefully what, not everything will get through, obviously, but hopefully what does get through will enable a

more resilient electricity ecosystem to evolve an energy ecosystem to evolve in Texas, one that's capable to withstanding these gales events because they're going to happen.

Q: For somebody that's directing the Center for Energy Studies, you're really in the catbird seat of major, major public policies study that's going to be underway for next year or two. What role would you like to play in that?

A: well, I think it's one that we have done a good job of playing in other dimensions and will do so in this one. It's really one of trying to dig deep into the data in a very micro-oriented way so you can dissect exactly what happened. We talked about winterization. We talked about transmission. There's another issue that's on the table that, quite frankly, there's not a lot of clarity about yet but it has to do with compression on pipelines systems and to move natural gas through the state and the increasing electrification of those systems. Now, what's interesting about this is pipeline distribution of natural gas is regulated by the Railroad Commission. Transmission and distribution of electrons is regulated by the PUC. Well, those two entities really don't talk to each other so it turns out in some cases, we have a situation where pipelines have been moving to electric compression, and I don't know to the extent of this yet, but it's actually some data that we're in the process of

gathering. But if the electricity system fails, then your compression fails which means you end up actually reducing pressure on pipelines and can't move molecules. If that's happening, then gas plants can't get gas supplies; therefore, they cannot generate electricity. You see the circularity here? So, you end up with the single point of failure on a system and you should never ever have a system designed where there is a single point of catastrophic failure. And so, that's another area of where we're digging into that to try to figure out the extent for which this was a problem because those are things that are correctible, and they need to be corrected quite frankly.

Q: Just hypothetically, the industry's focused on microgrids and energy storage. Buying new technologies help address this?

A: Potentially although even in the microgrid kind of discussion, some of the technologies that are being really emphasized as capable of delivering. On the Texas grid, they failed, too. So, it really is about building enough redundancy and resilience into a system that it can withstand these kinds of things, and the irony of the microgrid discussion, right, and there is some talk about of having capability to island yourself in events like this, that is emerging as well. But the irony of the microgrid discussion is it is effectively a discussion about

separating yourself from the rest of the grid at its core and notice what we were just talking about in regard to Texas and actually connecting to the rest of the grid, so these are issues that in some instances at the extremes will definitely run headlong into each other, and so there's got to be a balance; there's got to be a real discussion about these things.

Q: The last question I want to ask you is, Texas gets a lot of notice just because of its size and might and economy and a proclivity to go its own way. This debate's that's going to take place in the next few years over the future of the energy grid in Texas and the advent of massive amounts of renewable energy in the wings. How important is that to the rest of the country to watch and what should they be watching for?

A: Oh, it's massively important. As a matter of fact, Texas has more wind, solar, and battery capacity combined. It's largely due to wind but it's number three in solar and two in battery capacity than any other state in the country, and it is an island in electricity so when you think about just the sheer capacity which should be harvested quite frankly because the wind resource in Texas is phenomenal. But when you think about the amount of capacity that's been installed, without any real concerted attention being given to resilience, its just sort of happened almost as a matter of course. You've seen natural gas

really stepping in as coal is being reduced in Texas. Wind is growing. Solar is growing. Gas is growing, too. It's cheap, it's flexible and it's been really providing that bridge, right, that allows the intermittent renewables to get onto the system. But if you are designing your system that way, without an eye towards resilience and gas delivery infrastructure, then you have a problem because you have a system that is not resilient. And so, it really means thinking about things in an integrated way, not just thinking about more of one or more of the other. You've got to think about if we have more of one what do we need to do to make sure the entire system is resilient so you have to think about things in an integrated fashion and that's something that I think a lot of folks just haven't been doing sufficiently. They are people that have, right? I mean, some of these discussions have been sort of ringing at PUC hearings for a while around the country, but they're largely falling on deaf ears and so it's time for politicians to really step up and understand these issues because moving to a system with more renewables is a goal that we should be striving for, right? It's a cleaner, greener system but we also have to recognize that resilience and the social cost of reliability is something that has to be internalized.

Q: So, a decade has lapsed between the 2011 and the 2021 outages. The stories were told they were going to happen with increased frequency. Do you think the lessons of this year will be learned fast enough to head off the next major outage?

A: I am the ultimate optimist. I'm going to say, yes, just because of the depth and severity of this event. If we just went through an event like what we saw in February 2011, where the outage wasn't that long and the depth of the cold wasn't as deep, it probably would already be, out-of-sight; out-of- mind, to be blunt for most people in the public eye. But this was, I think, deep enough and severe enough that it's going to lead to some real action and then hopefully, some real substantive change but you know as I said, there's already more than a handful of bills on the House floor in the Texas legislature directly addressing various issues that have been identified as problematic.

Q: Okay. Well, thanks, Ken.

A: Sure.

Q: And thanks for listening to Grid Talk. Today, we've had the pleasure of meeting with Ken Medlock, who's the Senior Director for the Center of Energy Studies at the Baker Institute for Public Policy at Rice University. You've been listening to Grid Talk. You can send feedback or questions at GridTalk@NREL.gov

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END OF TAPE