Algorithms & Power Systems Architecture:

Using Historical Analysis to Envision a Sustainable Future

Oral History Project

Interviewee:	Bob Reedy
Interview Date:	July 23, 2024
Place:	Seattle Convention Center, Seattle, WA
Interviewer(s):	Julie Cohn, Sairaj Dhople, Daniel Molzahn, Jess Slater
Transcriber:	Temi

Keywords: Bob Reedy, Auburn University, Georgia Transmission, University of Central Florida (UCF), Florida Solar Energy Center, Department of Energy (DOE), solar, Lakeland Electric and Water Utilities, Energy Authority, Turbec, Eastern Interconnection, Balancing Areas, Florida Municipal Power Pool, Florida Power and Light, Southern Company, Orlando Utilities Commission, Florida Coordinating Group (FCG), oscillation, mis-operation, system protection, Southeast Electric Reliability Corporation (SERC), Electromagnetic Transients (EMT), inverter, blackout, black start, distributed energy resources (DER), under-frequency load shedding, hurricane recovery.

Abstract: Bob Reedy, currently a consultant to the US Department of Energy, reflects on his educational background and professional career. He studied at Auburn University and held positions across the electric power industry in multiple sectors. He begins with discussion of his time with Lakeland Electric, and the process of linking Florida utilities with the much larger Eastern Interconnection in the 1980s. He describes the frequency of system separations at that time, the use of under-frequency load shedding, the proliferation of balancing areas, and the common practice of keeping tie-lines open. He explains the interest in economic interchange to keep customer rates down. He describes witnessing oscillations on the system during the 2003 Northeast Blackout, and historical as well as contemporary debates about fragmenting large interconnected systems during disturbances. He describes the Florida power situation as "an island in waiting," and notes that separations are now

rare. He discusses the evolution of the power system today, especially as a result of added renewables and distributed generation. He discusses black start procedures and describes a black start event in which system operators had to purchase truck batteries during an overnight scheduled blackout. He talks about being a teenager in the back of the control room where his father worked during the 1965 blackout. He notes that Florida utilities were early adopters of under-frequency load-shedding, which was accompanied by debate over the set point on the relays. He underscores the collegiality and collaboration between engineers in the utility industry. He laments that regulation tends to be reactive rather than proactive. He describes being a system operator during hurricanes. He encourages students to focus on applying their math and science to practical challenges. He closes by affirming that his current work with the Department of Energy on solar-to-grid integration is the most satisfying of his career.

Note regarding Transcript and Timestamps:

Timestamps appear in the transcript but may not align with the recording. Pauses and interruptions may have been removed, and the overall length of the recording may be reduced.

Transcript:

Julie Cohn (00:01:09):

This is Julie Cohn. I'm conducting an interview with Bob Reedy on July 23rd, 2024, at the Seattle Convention Center in Seattle, Washington. Sairaj Dhople will be assisting with the interview as will Daniel Molzahn via Zoom and Jess Slater. Bob, during today's interview, we really are interested in the trajectory of your professional career, because it seems to me you have worked in almost every corner of the industry, from utilities to federal agencies. But we'd also like to know a little bit about your background and your education and how you found your way into power systems.

Bob Reedy (00:02:39):

That's a great place to start—at the beginning. And I think I had the unusual benefit of being the son, and with two brothers also, of our father who was in the involved in the utility industry from, from the mid 50s on through the eighties. So, I—when I decided to be an engineer and an electrical engineer and to be—I knew that I wanted to be involved in the power system, and there was a sort of an inherited thing that happened. So, unlike many of my colleagues at that era, aerospace was the big thing. We were going to the moon, and I was in an unusually small group of power engineers at Auburn University, but they did have a strong power program, so that brought me in early.

(00:03:53):

And I enjoyed it ever since. And followed on through working for a utility, then working for a wholesale energy marketer and working for a micro-turbine manufacturer. Then working, I'll lose count here in a little while, working for another for a transmission—Georgia Transmission—organization. And then back to teaching as an instructor for 15 years at UCF, again, in the power systems, but also systems integration of the solar system, solar panels and solar systems. That's because UCF has a strong—the Florida Solar Energy Center is part of UCF. So that got me involved and that brought me on upwards eventually to DOE where I'm a contractor actually but fully involved in the in the systems integration program at DOE, the solar program.

(00:05:14):

So, it just kind of wandered through. I think that's seven different careers. I'm looking for the next one. A couple more will do it for me.

Julie Cohn: (05:26)
What was the name of the utility you worked for?

Bob Reedy: (05:31)
Well my first, and longest time was Lakeland Electric and Water Utilities, which is now simply Lakeland Electric. That's a mid-sized municipal system in Florida. And uniquely in Florida, really to most of the country, municipal systems there have, have always had their own generation, their own control areas. And were not just distribution utilities. And at the time I began with them, there was a lot of activity in interconnection with a larger grid in Florida, because it's a peninsula. There's some unique problems there. So, Lakeland Electric, and then the energy marketing firm that I was with was called—is called the Energy Authority, not Enron. Though we made a lot of money off of Enron. And so that gave me a perspective on the market side of the wholesale business. And then the perspective on distributed

generation, distributed energy, and microgrids comes from Turbec, which was a Swedish joint venture of ABB and Volvo.

(00:07:13):

So, it was a competitor of Capstone, which is still surviving. Turbec no longer survives. And then finally Georgia Transmission, which is the G&T. Well, Oglethorpe is the Generation. Georgia Transmission is the transmission in the Georgia ITS.

Sairaj Dhople (00:07:41):

Bob, you mentioned some challenges about interconnecting Florida as a peninsula with the rest of the grid. Do you know what the history is? Was it one of the last states to be connected to the Eastern Interconnect?

Bob Reedy (00:07:54):

Not one of the last in, technically, but in practical reality. It was, it was in the mid '80s when Florida finally ended up with two 500 kV ties to the rest of the world, to the Eastern Interconnection. Prior to that time, during my early days with Lakeland Electric, we had three weak 115 KV interconnection. So, we had something like 20 gigawatts connected to the world through a very weak tie. And we actually, in the mid- late-'70s, we would separate typically 70, 80 times a year from the rest of the interconnection.

Sairaj Dhople (00:08:45):

Inadvertently?

Bob Reedy (00:08:46):

Inadvertently. So that led to Florida having a very, what we would call “progressive,” but others called “extremely conservative” prospect of—. We had strong reserve requirements that were much greater than the rest of the country, the interconnection. We had under-frequency load shedding program, which was almost unique at the time because we really had to do a lot of very intentional protocols to keep the system from collapsing. And we still had trouble sometimes.

Sairaj Dhople (00:09:38):

And so, this, let's say the tardiness in connecting to the Eastern Interconnect, is that the reason why Florida still has a lot of these balancing areas?

Bob Reedy (00:09:47):

Yes. Well, once the control areas were established, there was not a strong motivation to change that as it happened. And I was one of the representatives from our utility that formed what's now called the—is the Florida Municipal Power Pool. And that happened, timeframe of the early '90s formation of the Florida Municipal Power Pool. And that was for economic reasons, because each of us running our own control center had its issues. And we could group together. So, we did that. We formed a balancing authority out of some seven or eight municipal systems. So that did evolve, but it stayed the same. And today there's still—Tallahassee is still in their own control area: Jacksonville, JEA. So, the formation originally of having so many independents was, I think it was because in the early days, the '50s, '60s and early '70s, everyone was using the same, essentially the same generation, the cities, in the inner part, were not able to get transmission connections.

(00:12:01):

So, they had their own generation. And we actually, many of them operated with normally open ties, only as emergency ties, until the mid '70s. So, it became an area because we didn't have a strong, large Southern Company or Florida—. Florida Power and Light was definitely there. Florida Power and Light, for economic reasons, it made sense, they selected service territory along the coast. And then around when we had Tampa Electric Company and Florida Power Corporation, at the time, were focused on where there was population, and a lot of the smaller cities in the center. Sorry. That's an evolution that is different than most of the country where you had distribution utilities that were cities, that were just distribution utilities.

Sairaj Dhople (00:13:02):

Just one last question on that note. So, this was purely geographic the reason why these interconnections came in later, or were there other socioeconomic reasons as well?

Bob Reedy (00:13:15):

I think geography is the largest reason. I think there were not socioeconomic, but simple business reasons why building that strong transmission up through, and connecting up to Georgia, was not happening. It just evolved that we had such a, such a large amount of load when you combine the three IOUs and municipal systems, that connecting to Georgia was, there was not a market, I guess, and you had sufficient energy resources. We had capacity amongst all of ourselves. And the market, it was quite literally again, in the early '90s, late '80s at the earliest perhaps, that a strong incentive developed; and mostly around the idea that Florida Power and Light became an owner of generation in Georgia.

(00:14:48):

They bought into coal plants that Southern Company was building in Georgia. So now we had an intertie—oops, we better build, we absolutely have to build some transmission to get that capacity imported. But there was just not a—everyone had a similar generation mix. And I look back and see, because that was the era that I was managing a control center and also dealing with wholesale energy. And the reality was that municipal systems are motivated a little differently. And, well put it this way that the investor-owned utilities still, to a large extent, in Florida, there's some differences, but they are largely motivated, as they would, as you would have to have, with capacity and investment, rate of return on invested capital.

(00:16:07):

Because to take that risk, to build that capacity and build those transmission facilities, investors needed, the rate of return. Therefore, they are less motivated on cost of energy. However, the municipal systems are strongly motivated because the owners are their customers, and their bosses are the city commissions, et cetera. So, we were motivated as a municipal system, for strong reasons, to have lowest cost of energy. So, we would approach the investor-owned utilities with the idea of, the earliest ideas about economic interchange—here's your incremental cost and here's your incremental cost, and let's do an interchange and split the difference et cetera. And it accelerated from there. And then that was, that happened a lot. Particularly Orlando Utilities Commission was very strong, they made the first economic interchange deals and wrote the first rate schedules for economic interchange with Florida Power and Light. And that happened in the early '70s. So—

Julie Cohn (00:17:39):

So, as you were anticipating linking up your utility for more, something closer to 24/7 power sharing with this bigger system, what were you most worried about in terms of operations?

Bob Reedy (00:17:56):

Well, a big worry, and it remained for a long time, is that we are interconnected, and we built that interconnection around all reliability, and when we were deficient or, you know, we could help each other out. But because we all had our own generation and we had to plan for that, we were always concerned about what happens when there's a bigger system disturbance. And, we had many cases, examples of that. We knew we would benefit if we had a deficiency, but we also knew that we could not, the smaller use systems, could not typically bring down the interconnection. But the interconnection could bring us down. So that led to a lot of interesting discussions. And I see parallels today, and it's one of the exciting things about what I'm involved in today in that we had control areas.

(00:19:22):

Or at that time we called them control areas, not balancing authorities, because that, a much more practical term. And I would marvel in discussions with my colleagues, for a few years there I was the chair of the technical advisory group, which was—at the time, the reliability region was called the Florida, FCG, Florida Coordinating Group. And we had committees, and we rotated. So for a couple of years I was on the technical advisory group and I was chairing it, and we were having discussions about when a deficiency occurs and the frequency drops, we do have tie lines, and we can sum in real time, even accrued digital version, but certainly an analog version we can know that we're severely deficient and where that deficiency occurs.

(00:20:33):

And at what point do we—? We've already tried our under-frequency load shedding program and we're still deficient, and the frequency is not recovering. How about a, what we called a special protection system, where we had actually—punch open the ties? We tried, we did our best, but your area is so deficient, the rest of us are going to cut you loose. And so that went on, and in fact, when—we never did it, because we're all nervous about that. But when the '03 event occurred, August of '03. I had just, I was two weeks into my new job at Georgia Transmission. And first thing that was thrown on my plate was that event. And that next morning, we were all high-fiving and talking about how, hey, Georgia Integrated Transmission system is just fine.

(00:21:45):

We had lots of capacity. And, I was staring at the frequency chart and the next day, and it just like, whoa. And I look at it, I keep it with me, and the whole interconnection went through a, about a one-third Hertz oscillation, and guess what? It was an undamped oscillation. It was exploding. And the only reason we survived, the Eastern Interconnect survived, is because we had some mis-oper—what they called "mis-operation" of some second zone distance relays. And there was a sequence of transmission that tripped enough to a point that it changed the parameters of the oscillation. And we damped and we came back down, but the entire Eastern Interconnection came so close to a severe, which would've been—. At that time, and still today, there's not adequate loss-of-synchronism protection on many generators, certainly at that time, because it's a very difficult protection question.

(00:23:10):

So, we would've had loss of synchronism, et cetera. And I can go on and on about how scary that was. But I was assigned to be on the working groups to write the report, et cetera. And one of the strongest proposals, that did not pass, was exactly that. That we would take major regions of the country, we would do real-time adequacy calculation assessment, and after a sequence of under-frequency load shed, or other actions that we would open ties and would fragment the system. Now, why do I bring that up? It's because today one of the hottest topics is, if you follow the projects that even DOE is looking at, are taking advantage of much advanced communications and control and to actually intentionally fragment the system.

(00:24:25):

And it's easiest to talk about on the distribution level where you can reconfigure feeders on the fly, but we actually need to look at that nationwide too. So, this is kind of like back to the future, you see. So, we see that coming today with power electronics, communications, and computing power. We can actually make a control area, become an actual control area, and not a balancing authority, take control again.

Jess Slater (00:25:03):

Dan, do you have any questions?

Bob Reedy (00:25:05):

Oh, you're not in the room, Dan, so I'm sorry.

Daniel Molzahn (00:25:09):

No, no worries. No worries.

Bob Reedy (00:25:10):

You need to ring a bell or something like that?

Daniel Molzahn (00:25:13):

Yeah, no, no. I'll rely on Jess to call-on me. No, I do have a couple questions. So, you mentioned the challenges in operating Florida before these 500 KV lines were installed, and then there was these economic reasons for installing them. Has the installation of those lines basically addressed the issues that were there before or is there still challenges today?

Bob Reedy (00:25:40):

They addressed the frequency of those separations. And they're very, very rare now. But as you can imagine, they're much more severe when they do happen because we are dependent on those—. The previous scenario, we didn't count ourselves as, really, very well interconnected. Florida was an island in waiting. We called ourselves an island in waiting. And it was this really large peninsula. Florida is actually more challenging than Oahu or another large island, because it's many times the load and generation, and it's stretched out in a way that is, the transmission is, again, very stretched out, very high impedance and very—. So, when we have them now, and we've had a few in the years since, there tends to be consequences. But because of the history of Florida and the Florida Operating Committee, which became the Florida Coordinating Group, which became the Florida region of, subregion of SERC, and now it's part of SERC. But the whole evolution it—that history has led us, again, to have in place a lot of aggressive recovery, prevention and recovery.

(00:27:29):

And so, I've—again, I sound like I'm proud, but I am proud. Because I think we were in a place that we had to do this early on. And now the technology is much better in terms of the hardware, communications, control that we haven't seen severe disturbances in many years. We've had, I'm trying to recall things, four or five years ago, there was a delayed clearing fault that that did result in some under-frequency load shedding, but there wasn't blackout, loss of units, have to restart from scratch. We caught it and arrested it, and that sort of thing.

Daniel Molzahn (00:28:23):

I got it. No, this is really fascinating. I have a lot of students from Florida, and we get a lot of them from Florida to Atlanta, so I'm sure they would find this just incredibly fascinating. I did have a couple other questions that I can follow up on. One, you had mentioned, this idea of fragmenting the system when there was a problem. And I've heard that suggestion a handful of times, both in the US and in Europe, and in different contexts. And, you said that it was a strong suggestion, didn't get adopted. Do you know why? What was the motive or kind of the justification for not doing that?

Bob Reedy (00:29:03):

Extreme caution. We're talking 2003, the latest time when it was really brought forth and looked at seriously. But that was 20 years ago, and the communications and control issues, rightfully had us working. The speed of communication, the reliability of communication and control, and being able to make that—. I said something rather glibly, which is like, we can know when we're deficient, but that's a dynamic problem. It's not like a static calculation. And we weren't able to then, and we're still working on being able to model and simulate what really would amount to a successful separation. So, I need to get that clear right now.

(00:30:17):

That's why we're still working on it, is because there's lots of issues with—. Just what kind of studies do I have to do just to do an interconnection today? EMT, we're trying to evolve what type of analysis. Imagine trying to do that and develop a consensus on a practice that is a compliance requirement, that you separate and fragment the system. Because it's a big oops, if you don't do it correctly. So, I have to be honest, it's rather frightening to think about, I'm going to basically dump a big part of my interconnection. But the truth is, it's just engineering, and we're going to get there; that's what the fun is.

Daniel Molzahn (00:31:24):

So maybe let me follow up on this quickly. This is an interesting point. So, do you think the system is getting more challenging to model and simulate, faster than our simulation tools and understanding of the system are growing? So, in other words, are we approaching the point where this would make sense, or are we getting further away from the point where this may make sense?

Bob Reedy (00:31:48):

I'm optimistic. The system is radically changing, primarily because of power electronics in particular, and the distributed nature of generation. Again, my whole thought is, we're back to the future. And we started with a, from Edison, we started with a distributed system. And, eventually, transmission. You guys know the whole history side. But if you think about it, we're back to the idea of going to a distributed system. And now new generation is popping up, down on the distribution system, and then at the sub-transmission level. So, the system is certainly more complex. But the good news, and the optimism I have, is that the equipment that is going in is almost universally controllable. And we're talking about software-defined inverters now, that's coming thing.

(00:33:03):

So, we have the means to do it. It's just, there's going to be a few years, and I hope only a couple of years, before we're able to have a uniform model for every inverter. And now we'll know what will happen. And now we can take that leap and say, "if we don't separate this region in the next three seconds, we know what's going to happen and it's a bad thing, and we're going to do it." So, I think we can talk about that.

Daniel Molzahn (00:33:52):

That's really interesting. And I appreciate your optimism. Maybe one other question before I hand it back to Jess and Julie. But is the consequence of the blackout that you have to do a black start afterwards? If there were a major blackout of the type you're describing. I guess this is, again, somewhat speculation. Because, as you said, we've not had a whole Eastern Interconnect-wide system blackout. But how confident, maybe this is an unfair question, but how confident are you in the black start procedures that we have in place? Especially as the system becomes more dominated by inverters, and DERs, and all these devices. Are we in a good spot with this, better or worse?

Bob Reedy (00:34:41):

We're better, much better, with lots of DER. Because we can boot up the system from the small level. See, the challenge when I was operating, the black start procedures were, you shut down everything, and then you start at the big power plants, and you start a diesel, and you bootstrap slowly, and then you get the auxiliaries going on the boiler feed pumps and everything. And then you start back, and because you had big steam turbines, or you could use gas turbines, but it was starting with very large generation and working down. Where the optimism I have for the future is, that with so much generation out on the lower parts, lower voltages, in the distribution, that we can develop these protocols to bring up at a substation level, and then on back up and the big central station power plants, many of them are now solar and wind with batteries.

([00:36:02](#)):

So that's super for black start. And the few remaining steam turbines, it's almost like we can deal with them at the end, after we get everything running, because we use batteries. So, I'm happy about the future. I was involved in some black starts back in the day, and they're brutal. There's a lot of, "oops, that's too much." We trip again. Back off. Start all over again. We, oops, we energize this transmission line, and because it's unloaded there was very high voltage, we shunt capacitance, and so therefore we had to trip it on over-voltage and start all over again, so it—. I'm sorry, Dan, you—

Daniel Molzahn ([00:36:59](#)):

No, that's great. That's super interesting. If I can take a few more minutes, I'm curious. Can you tell us any anecdotes or any stories. I've not talked to somebody who's actually—I've heard about black starts, read about black starts. I've not talked to anyone that's actually been involved in doing one. What's that process like? I'm sure it's incredibly stressful.

Bob Reedy ([00:37:20](#)):

Right. You have all the procedures you thought ahead of time, written out. But I remember one case where, it was not a connection-wide or a Florida-wide black start. It was literally my utility black start because of some control work that we were doing at our largest power plant. And we shut down everything and we could not, because of the switchyard we were working in, we couldn't close the interties. So, we literally had to do it ourselves the old-fashioned way. And we lost the DC batteries that, for the substation, for the switchyard control system, because—anyway, so we literally had to start from getting a 48-volt, go out and get a bunch of truck batteries, and we rigged up, and we made a 48-volt power supply so we could energize the relays in the control house so that we could then turn around and do the next step. So that's what I'm saying.

Daniel Molzahn (00:39:08):

Wow.

Bob Reedy (00:39:10):

That was a gnarly night. That was—

Julie Cohn (00:39:15):

How many customers were affected by that?

Bob Reedy (00:39:17):

Well, at that time, the utility had about 100,000 customers, which is—

Julie Cohn (00:39:23):

More than that.

Bob Reedy (00:39:24):

200—230,000 people, or something like that.

Julie Cohn (00:39:28):

But it happened overnight?

Bob Reedy (00:39:31):

Yeah. It took us about seven hours just to get back to—but that's what I'm saying about—do that on a regionwide or a large area or a national or interconnection level where you've lost gigawatts of generation and it's all central station large stuff. So, they all have to do this. And every time you've got issues with the overloads on the flows, you've got voltage issues, matching—because you can't bring on without matching some load to keep the frequency stabilized. So, all of that is exacerbated by the large central station, and transmission, backbone transmission nature of our—, what still today and certainly was in the past. And that's why I get excited about where we're headed with power electronics, and ultimately, we go big scale, back-to-back DC, inserted in the system so that we could actually control flows, and do things in a really fast way.

Daniel Molzahn (00:41:01):

And do you think that would allow us to be more, I guess, aggressive in the sorts of fragmentation method you're describing?

Bob Reedy (00:41:07):

Yeah.

Daniel Molzahn (00:41:08):

Like people would be okay with it if it was in place?

Bob Reedy (00:41:10):

Right. It's like, now you're comfortable because the consequences of things are broken down in small areas, and things. It's like having multiple backups of your document when you're—<laugh> instead of one big disc.

Sairaj Dhople (00:41:38):

Bob, you—

Daniel Molzahn (00:41:38):

No, I appreciate it. This is a really fascinating point, so I'll pass it back to Jessica, or Julie.

Sairaj Dhople (00:41:45):

Bob, we've talked a lot about the Florida power system, and you speak of it in a very intimate and very familiar way. And you mentioned your father was also in the utility business. Was this also in Florida?

Bob Reedy (00:41:58):

Yes. He was at Orlando Utilities Commission. And that's, it's next to Jacksonville. It's the largest system in Florida. And so, he was there until he retired in the late '70s. And he was involved in the early Interconnected Systems Group, which became NAPSIC, North American Power Systems interconnection, which became NERC, I guess, eventually. So, he was in that era of time. And because the nature of Florida and the municipal systems, they worked a lot together with, and they formed what they called the Florida Operating Committee, which was all a voluntary type of thing. And it had to deal with a lot of these issues, that group of people. And it was—at a time, everyone knew everyone, and it was a much more collegial; there weren't legal penalties for non-compliance and that sort of thing.

(00:43:40):

So, it allowed people to just solve, engineers just to get together and work and solve the problem. And at that time, I was in my teens, and I mentioned to Julie that I, that was actually, when the '65 blackout in the Northeast, it started a lot of the idea of reliability guidelines and operating practices. I had gone from school, from high school, over the way, to ride home with my dad. That was the practice of doing that. And so, I sort of got to witness, the event, and I was fascinated by the—it was a day later before I had someone, one of the operators explain to me—but I was fascinated by the idea that here I was a thousand, 2,000 miles from New York where all this blacking out, blackout, occurred. And there was—you could see on a frequency chart, the old analog frequency chart, the impact right here in, right here in River City, as we used to say, right here in Florida.

Sairaj Dhople (00:45:01):

So let me take you—

Bob Reedy (00:45:02):

And so that fascinated me. How dynamic and living the power system was.

Sairaj Dhople (00:45:07):

So, I just want to take you back to what you said. So, you were coming back home from high school?

Bob Reedy (00:45:12):

Well, I'd been at school and—

Sairaj Dhople (00:45:13):

Right. And your dad was driving you and you saw the lights go out, or what—

Bob Reedy (00:45:17):

He was—I cut a lot of corners there. He was the director of transmission at Orlando Utilities, and the system control center was in his responsibility, and his office was in the control center. And so, I would ride home from school. I would walk over after school and ride home with him. I'm just saying, those were the days that kids are in the back of the operating—of the control center doing their homework. There was no security, no, so it allowed a personal connection.

Julie Cohn ([00:46:00]()):

Just a real quick question. So did Florida, or did Lakeland install the under-frequency load shedding relays? Did the Florida utilities do that before 1965? Were they already in place then, or afterwards?

Bob Reedy ([00:46:15]()):

It was after '65, but before most of—most, if not all, of the other regions of the country did.

Julie Cohn ([00:46:24]()):

Were they already in the queue there?

Bob Reedy ([00:46:27]()):

Not in ’65, no.

Julie Cohn ([00:46:29]()):

Because I think maybe one or two were in existence somewhere in the US.

Bob Reedy ([00:46:31]()):

The technology was there and that was the motivator. Between '65 and probably '69 is when those under-frequency relays were ordered en mass and installed. And a lot of debate in the Florida Operating Committee about what the set point should be, and "Oh, no, I'm not gonna deliberately black out my customers, I can't do that." And then I heard stories from my father and others. Well, you can black out 30% of your customers or you can black out a hundred percent of your customers. What are you going to do? That kind of interesting, sort of political, legal debate versus the engineering reality that you just gotta do what you gotta do.

Jess Slater ([00:47:30]()):

I wanted to ask a quick question.

Bob Reedy (00:47:32):

Sure.

Jess Slater (00:47:32):

You said you were going to see your father. Do you remember any of the conversations that were going on, or if there's particular things that you noted that were going on, that a lot of the utility people were speaking about during that blackout? The 1965?

Bob Reedy (00:47:49):

Well, of course, I was 15.

Jess Slater (00:47:52):

Okay. Yes, exactly.

Bob Reedy (00:47:54):

And I was in the back of the room, and I just noticed a lot of activity and a lot of noises and alarms and everything. And so, I also knew to stay out of the way. No, it was the next day that I actually started asking questions, and people were able to talk to me more about it. But yeah, it was an exciting time. I was trying to represent—it probably had a lot to do with my passion for system dynamics and the operating reliability of the bulk power system today. It's just because of that day, that very moment when I said, whoa, this is cool. This is New York City, and look at it, it's affecting us here. And all of the people I know here are going crazy and—

Jess Slater (00:48:58):

Yeah. I see, yeah. Did that play any role into you—obviously, your father is—was within the same industry, but did that play any role into—? Or did it change your attitudes towards anything?

Bob Reedy (00:49:10):

It made something real that was previously abstract and boring. Because I wasn't excited about poles in the ground and wires and the mechanical or the physical parts of the power system, but this was a living thing; this was really interesting. And also, the impact on society became vivid, because I got to hear the news and see all the—how people were caught in elevators. And so, it really brought home, because we had, in Florida, and we still have, frequent local small outages. When thunderstorms happen, we have circuits trip a lot, and a lot of lightning, a lot of wind, and a lot of trees. But all of those events were just local and small and not long-lasting for eight, or two days, or anything like that.

(00:50:41):

So, when I tie that with hurricane events that are also something else, I can talk a lot about, where you do have long, and massive destruction and you see how much that affects society and economy and businesses and everything and everybody's lives. I really like to come full circle and think of the work I'm involved in now with, resilience and restoration. And we can do so much with PV and with batteries and power electronics. So, the power grid is not boring at all. One of the interesting things is that when I was early in my career, distribution—because there were none of these things that I'm talking about; it was—distribution was not exciting, and I was focused on system protection, transmission control, bulk power system, because that was exciting. But again, back to the future, we find ourselves, if you are a distribution engineer today, you're in the center of the storm because you're trying to put 40- or 50-percent of our generation out there on the feeder. And so, it's become a whole new flip.

Jess Slater (00:52:15):

Is there any particular question that—and if not, I have another to shift in towards the overall career.

Julie Cohn (00:52:24):

So—oh, okay. I'll ask one more that relates to this phase of your career then, which is, when you, at your utility, were facing a new technical challenge, where did you look for collaborators or cutting-edge ideas about how to address them?

Bob Reedy (00:52:44):

We had then, and still today, the advantage in our industry, the utility industry, of—because we are fundamentally for the common good, and we are fundamentally not competitors, because we have service territories. And we really, we are collaborative. It's a very collaborative culture. And so that's the source of resolution, is to work with each other. And we do find that there's a downside to that because we don't—because we're comfortable, as a utility industry. We think everything is going to be okay. So, I guess, I'm trying to pick my words carefully, I think the injection of a whole new paradigm of generation, distributed generation, owners of generation, and that brings a whole new energy in and a whole new resource for solutions. So back to the—there's money to be made. So, innovation is really hitting the industry really well, really hard.

Julie Cohn (00:54:41):

So, I guess I was thinking about it a little differently. Like, would you turn to Florida State University to find out what the researchers there were developing? Or did you turn to colleagues at other utilities primarily to find out how they were solving similar problems? Did you come to IEEE and ask who here is working on this? How did you find information you wanted?

Bob Reedy (00:55:08):

Well, firstly, it's all of the above.

Julie Cohn (00:55:12):

Okay. Well, that's a good answer.

Bob Reedy (00:55:13):

Because my own personal—I just love to try out, to learn new things and talk to people. Now if you're asking what is a common practice for utility folks? I think it's changing because it's very, very interesting now, where it wasn't; it truly wasn't. And now it's really, really interesting. I think about when I was in grad school, there were four of us in the electrical engineering program, and there were four of us in power systems, and there were at least 70 or 80 grad students in communications, aerospace, electrical computers, computer control design, and everything. So that's just flipped. In my recent teaching as an instructor at UCF, power system classes were sold out every semester, or so, and it's a great program there too, so—but yeah.

Jess Slater (00:57:04):

Asking an overarching question. Based on your experiences within the industry, how would you say governmental policies or regulations played a role in the new design and operations of the utilities you were involved with?

Bob Reedy (00:57:22):

I think that the regulation has always been reactive, not proactive. And that sort of makes sense. We saw problems and risks early on, and eventually there would be an event, whether it's a hurricane or it's cascading outage, or it's a fuel shortage. And these things bring to the public perception, and then therefore to the regulatory agencies and the legislatures, legislators, that, “oops, this is a problem and so let's fix it.” And so, we have a reactionary—. And that's one of my hopes is that today, working as we are now, the industry and the government, and it's—I have a little window in the Department of Energy's perspective—is we're seeing this coming, and we're really trying to surface the needs and the response to it. So, it's a healthier—we're not there, we're still reactive, from a regulatory perspective.

Jess Slater (00:59:05):

What would you like to see shifted? Or, you say we're not there, what would be needed to get there, in your opinion?

Bob Reedy (00:59:15):

I think it would be, I would like to see more risk-taking. Not risk, because risk is real. But more willingness to endure perceived risk. And that's the biggest problem, is the perceived risk. "If we do that, oh my gosh, what if we're wrong?" That caution, I don't think we can afford so much anymore with the pressures that we need to transition the industry. So, I think we need to have a little more faith in our engineering ability and our analytical abilities. Yeah. That sounds a bit arrogant. Like, we're the engineers, we're going to fix this. I think that we need to be given—, we need to assert more—, a faster change. I'm fumbling that answer because I'm—

Jess Slater (01:00:43):

No, no worries.

Bob Reedy (01:00:45):

I've not thought about it in that way.

Jess Slater (01:00:47):

I'm curious if you have any advice, because knowing that, like, the conservative nature of power system utilities of not wanting to change or having resistance to risk, what advice would you give to incoming students who are going to enter the industry to facilitate those risks, or bringing up things that would, they would be more open to taking?

Bob Reedy (01:01:09):

I would say, "Know your stuff, do your homework, and then assert yourself." I mean to step out and understand your inherent fallibility as well. But also, you too can do this is something. The conversations can go back to work experience. Oh, here comes a hurricane, we know they're coming. We know when the winds get to 70 miles per hour, and the trees are such, and all this, we're going to start losing every feeder we have. And we're going to lose it to a limb, a short circuit. We're going to melt conductors. We're going to tear things down. We're going to leave energized lines on the ground. And it's very, very dangerous.

(01:02:29):

And we know it's going to happen. Here it comes. And I'm in the control center. I'm responsible for the system. Why am I letting it happen? Why am I not punching off every feeder in the system? And that type of "knowing your stuff" and knowing—, and everybody's, "oh yeah, but what if, what if you turn out the lights and we would rather that an act of God cause it than us doing it." So, I'm just telling you, I don't mean to be sarcastic, and I don't mean to trivialize that. It's an example of, if you're an engineer, you understand, and your data is right. You do what is right. Now you can reflect that same process into design, or development of a control response because, don't be afraid, when you know your stuff.

Jess Slater (01:03:50):

It's interesting because you said of knowing your stuff, but even within this evolving economic landscape or how during your time you're getting the computers coming in, how would you say what aspects are important for students to have? What is the stuff that they should know with everything evolving?

Bob Reedy (01:04:09):

That's easy for me to say. Stuff. A student is following a track and following a particular thing. So, the fundamentals are always there, the math, and the physics, and/or chemistry, depending on how you want to call it. They say that all physics is chemistry, and then the chemists say all chemistry is physics, or whatnot. But the science. The math, the science, and then the most important part is the application of that into the real world. And that's the greatest gap that often occurs, is that a student will be pushed hard on the theoretical concepts and miss out on just literally applying it to some practical solution or some practical device or some particular product that is real and not theoretical.

Jess Slater (01:05:27):

Dan, do you have any questions?

Daniel Molzahn (01:05:34):

I did have two, both of which you've touched on a little bit. And, what goes back aways. So maybe we'll start with the more recent one first. So, you had mentioned that you could talk about hurricanes, you did talk about them a little bit, but I'm curious to hear a bit more about this. So, I'm a mid-westerner. I come from Wisconsin and hurricanes are this sort of very terrifying thing to me. And I moved down to Atlanta, and I have all these students from Florida, they're like, oh, well, hurricane is coming in. We board up our room, our windows, and it's fine." It is such more accepted.

Bob Reedy (01:06:05):

Party down!

Daniel Molzahn (01:06:07):

Yeah, exactly. This is a very foreign concept to me. And so, I'm curious if you could just give a little bit more insight over how do you prepare and respond to these sort of very extreme events, and what implications does that have for the system?

Bob Reedy (01:06:24):

Well, they are unique, and from the power system perspective, having been responsible for response and recovery of—I don't want to say I lose track—but at least seven or eight storms that came through my area. I do have perspective, in that it is—, first of all, you want your recovery to be very systematic and very—, starting from where you know everything is secure and then you move outward. So that it's a whole process and I know we don't want to bog into that. One thing I do want to say, Dan, give me a hurricane any day over an ice storm, because—

Daniel Molzahn ([01:07:31]()):

I don’t know, I'll take the ice storm. But I understand that. I'm curious why?

Bob Reedy ([01:07:35]()):

Yeah, the ice storm is a terrible thing for recovery because of the environment for the workers that are trying to—a hurricane goes through, four hours later you have blue sky or broken clouds, and it's just hot. But you can see, you have—and your hands aren't frozen and—. So anyway, so the hurricane response is very methodical, and preparation in advance, agreements with other utilities, staging, it's coming. So, you stage your materials and your crews, and your foreign crews or your incoming crews, in the proper way. Have all that worked out in advance. We were involved in recovery for others. Hurricane Andrew hit South Florida, and Homestead was one of our reciprocity agreements. So, I'm there the next day. We chartered a plane and flew in, and our crews came later, down there. So, it's very dramatic. There's some tolerance from the public for a few days, because you can see the devastation, and you understand the power of nature. But after five or six days, it becomes pretty brutal. It happened in Houston last week. I hope it's over now, but heat and all that is really—. I guess I'm just having more reminiscing of all the troubles than giving you a solid, here's what you got to do formula.

Daniel Molzahn ([01:09:52]()):

No, that's really interesting. And it's—just in hearing the perspective of, how you do think through it and how you do prepare for it. And the agreements among the utilities, agreement to address that. Are those based on a lot of personal relationships? Or it's based on longstanding agreements? Or it's a very formal legal thing? Or how do those come about?

Bob Reedy ([01:10:12]()):

It evolved from personal—everyone knew everyone and there was just—it evolved. But it has become—we have formal reciprocity agreements, all kinds of indemnification and legal stuff and everything, and then the financing and how you get the money and who gets—all that is very much worked out. And logistics, material delivery. One of the huge problems of the industry is: everyone chooses a different, instead of 795 MCM, we have 954, and everyone has different conductor sizes, different transformer, or different voltage levels. So fortunately, things like poles and insulators, you can kind of use anybody's—. So, there are—for physical destruction, there is work to be done on standardization and logistics, but it's well developed.

Daniel Molzahn (01:11:29):

Great. No, no, very interesting. And then the other question I had, which, maybe is a quick one so we can move on, but I'm curious, we were talking about under-frequency load shedding before, and how Florida was among the first to implement this. How, I was always curious, how do they decide, or how do the engineers decide which feeders get which level of under-frequency load shedding? Like which percentage of, or how sensitive essentially for each of the feeders?

Bob Reedy (01:11:58):

And sensitive is a good word to bring in, because it's sort of the flip side of resiliency and restoration. In other words, we all talk about bringing back critical facilities first. Well, they should also be the ones you trip last. So, there was, in the beginning, it was sort of intuitive. But it has become much more rigorous where you try to be sure that you shed for under-frequency, you shed as little as you can in terms of critical facilities. And to the point that you may even put a recloser, and an under-frequency relay on a midpoint on a feeder, dump some of the end of the feeder, and keep the fire station energized or whatever. But originally it was not that rigorous.

(01:13:08):

It was just, we've got to get rid of some load, we have to do it. And we would just apply it, feeder-by-feeder. And then we would, we actually—and many utilities would do this—if you had the luxury of selecting, you had extra feeders, then you would arm that, that load shed for the next event. You would put the burden on some other feeders and that type of thing. So, it was a little informal in the beginning. The idea was equity, but we've changed it now. One of the coolest things about the work that I'm involved in now is, again, with power electronics, with communication and control, and with—we can shed under-frequency load on a, literally, on a house-by-house basis. We can use demand-side real-time response for under-frequency, or for disturbances as well as just capacity or economics. So, it's really exciting what we can do now, and effectively keep all the feeders energized, but just dumping discretionary loads that are not hurting anyone.

Daniel Molzahn (01:14:39):

Got it. No, that's really fascinating. I've always been curious about that. That's really interesting to know. Thank you.

Jess Slater (01:14:48):

As a general question, if a general audience could walk away with one important thing to know, what would that be?

Bob Reedy (01:15:02):

The grid has transformed in five years. It has reverted—. I knew that I would work on a question like that. This is not your grandfather's grid. It will soon be very secure and very resilient. And that's the most exciting—is the resilience component. It's always been smart. We talk about smart grid all the time. Well, it's always been smart. We've always had control, and we've had relays and monitoring and instrumentation, and it's been sophisticated. But now it's become anticipatory rather than reactionary. We're able to do things and prevent things from happening. So, I think the takeaway is, if you're interested in a really promising and rewarding thing, is to get involved right now. We'd like the grid to become absolutely boring. Just never—we don't think about our phones not working anymore. But I remember sometimes long-distance calls were a problem, and it was a big deal. And so, we want that to happen in the grid. We want it to become so boring that nobody even knows it's there, or not there, which is—and also sourced from very healthy renewable resources; solar is big on the list.

Jess Slater (01:17:42):

Is there any closing question?

Sairaj Dhople (01:17:45):

I guess I'll just ask you a closing question, Bob, and you can leave out your present employer since you're working with the DOE.

Bob Reedy (01:17:52):

Yeah.

Sairaj Dhople (01:17:52):

But of all the other industries and domains of this business that you've seen, what has been the most rewarding part of your journey so far?

Bob Reedy (01:18:02):

This one.

Sairaj Dhople (01:18:03):

This one?

Bob Reedy (01:18:04):

This is it.

Sairaj Dhople (01:18:05):

I was hoping you'd leave this one out and then go one step back.

Bob Reedy (01:18:08):

Well, if I go back one step, I will take it to the utility itself, the operating utility. And I—we all know Maslow's hierarchy of needs. And so, when I was in the high school—well, my senior—I had a scholarship—academic, not athletic, obviously— from Martin Marietta, defense company, made missiles. And all of my friends were excited about aerospace. We were going to the moon and everything. And I—part of the scholarship was I could work for them in the summer. So, in my first two summers, I was making weapons.

(01:19:07):

That wasn't very satisfying. The next level, you can be an engineer who makes video and entertainment and makes life easier for people and more fun. And so, a lot of my colleagues, friends, were doing that and were working for communications companies or something. And then—but I got involved with the utility, and now you're responding to a basic society need. And it feels really good. And then it feels even better when I was involved in building the first coal plant in Florida. And that feels kind of bad now because, I'm trying to make up for it with solar power. So, no, I'm going to—sorry, I'm going to say this is it, right now.

Sairaj Dhople (01:20:07):

That's fine.

Bob Reedy (01:20:07):

But it did evolve from bad things like weapons on.

Jess Slater (01:20:18):

Thank you so much for taking time to be with us.

Bob Reedy (01:20:21):

It was fun. I thank you for being interested to discuss it. I always enjoy conversation.

Jess Slater (01:20:38):

Thank you.

[End of interview]