Algorithms & Power Systems Architecture:

Using Historical Analysis to Envision a Sustainable Future

Oral History Project

Interviewee:	Patrick Panciatici
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Abstract:

Patrick Panciatici, a senior power systems engineer with the Reseau de Transporte d'Électricité Français (French Electricity Transmission Network - RTE), discusses his education and professional experiences in the power industry in France. He studied at Supélec, a school of electrical engineering, completing a master's degree. His training included work in a military facility. He worked at Électricité de France (EDF) with an early focus on load forecasting. He developed a model still in use thirty years later. He discusses his research and development team at EDF, and collaboration with researchers in Belgium. He worked on modeling challenges including secondary voltage control. He explains the importance of reducing complex problems to simplified models that will be useful to system controllers in real-time. He

describes using physical scale-models at EDFs to test algorithms before they were deployed on the real system. He notes that the limited computational capacity available during the 1980s made this necessary. He mentions a demonstration of his physical micro-grid at a Conseil International des Grands Réseaux Electriques (International Council or Large Electrical Systems - CIGRE) meeting in 1986. He underscores the value of both analog and digital simulation. He describes running tests in a control room in Brittany for a nuclear power plant. He discusses moving to contingency analysis around the year 2000 and coordinating modeling across teams. He emphasizes the culture at EDF that encouraged understanding technologies from the inside out and building their own software to operate their systems. He discusses coordination at the European level and gives a case study of an incident in Germany involving a collision between a ship and a bridge that led to significant load shedding, but not a blackout. He explains the challenges of voltage problems on the Brittany peninsula. He describes moving his team from EDF to the separate Reseau de Transporte d'Électricité Français (Electric Transmission Company of France – RTE) and building an R&D program there. He suggests that successful R&D occurred when his team developed solutions that could be deployed when new problems emerged. He describes working within RTE to bring senior management on board. He discusses integrating Ukraine into the European grid after the start of the recent war there. He explains that new challenges often emerge during coffee break conversations. He offers that the French are very good at imagining negative scenarios, and this serves well for developing models to address future challenges. In closing, he emphasizes the importance of thinking holistically about power systems to meet the needs of the future, the need for decentralized system modeling and control, and the need to integrate R&D.

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:

Sutanwi Chatterjee (00:00:00):

This is Sutanwi Chatterjee. I am conducting an Interview with Patrick Panciatici, on 18 July 2023 at the Marriott in Orlando, Florida. Dan Molzahn, Rachel Harris, Julie Cohn, Sairaj Dhople, Dominic Gross, and Brian Johnson will assist with the interview and can ask questions. During today's interview we're especially interested in your early work on power system control and analysis. So if you could tell us about your work on power system control and analysis. And we'll also begin with some introductory questions and general background information about you. Please describe your educational background and your professional positions in the field of power engineering.

Patrick Panciatici (00:00:55):

Okay. In France we have a very specific education system. There is a school of engineering that—it's a big one that is called Supélec—for electrical engineering. I did that. It's more master level. But in France, you know, we have this system that is very selective. We are not pushed to do a PhD after that. It's a bit similar to Case now, but that's enough to find a good job, enough without a PhD. In France at this time, there is this interesting period that we have to go to the military services, but we have a very interesting scientific position in some kind of weapon factory. And I was doing something anti-ship, my side, doing some control on that.

Patrick Panciatici (00:01:50):

It was very interesting. But after that I chose to go to EDF, because EDF has some people that give some courses in Superélec and they did very crazy stuff on adaptive control, for example, things that are very advanced at this time. They're doing something that is very cool and something that is good for energy. It's not like military stuff. I went to this big thing that was EDF Research and Development Division, and I start with something that—I don't know, I can stop there, after that I can—

Julie Cohn (00:02:35):

You can carry on.

Patrick Panciatici (00:02:37):

Because then I can enter more technical, I don't know, start with something more—load forecasting? I tried to apply signal processing method to load forecasting. It was very new. It was not obvious for me that it was very new. It was because—it was for short-term forecasting, I used some kind of Kalman filter, something like that to do that. And it was an environment at EDF R&D that was so advanced that for us it was a bit obvious. For me it was kind of—I have some courses on that—just apply what I learned in my class to this problem and then we develop some method to that. And then also I did something on the impact, on the weather condition and consumption, and I tried to estimate some transfer function, and it was not working very well. I generalized some idea around that. And I developed a very good model that remained for, I don't know, more than 30 years, I think, in operation in EDF and RTE. And now they changed just recently to another one. But I'm very proud of that. I believe that I have a very big impact on the accuracy of the forecast with this model. I am quite proud of that.

Sairaj Dhople (00:03:49):

Patrick, can you tell us what EDF stands for and what it does?

Patrick Panciatici (00:03:53):

Yes. EDF, Électricité de France, was a big integrated company, vertically integrated, that did everything from distribution, transmission, generation, nuclear, hydro, everything. Planning, planning the capacity for everything, generation, grid, and very integrated monopolistic company—state-owned—and it was possible in this company to have a very long-term strategic vision. And this is why they developed the nuclear power plan, I believe, without any kind of market consideration. The short term, yes, but it was this kind of very long-term thing that they are able to plan the system.

Sairaj Dhople (00:04:33):

And is the electric power industry still vertically integrated in the manner you suggest, in the description of EDF today?

Patrick Panciatici (00:04:39):

No. Since 2000 we split the company in different pieces and then, RTE is just the transmission part. The system was a big, big corporation integrated in some place in Paris. And it was very nice because there was a lot of people and there is a critical mass there, with many interactions. And people were doing something that was sometimes very theoretical. And we have some time to do something like that. I think that the time constant was very different. We were planning for nuclear, you know, it was not to have results for tomorrow. It was more—

Daniel Molzahn (00:05:24):

And what was the timeframe for this? So, when you're describing this, this is the '70s? '80s?

Patrick Panciatici (00:05:26):

It was '80s. Okay. '85 for me when I arrived. Then I have this first position in, I stay there for forecasting, I don't know, four years or something. And then I moved to something that was more to generate, to have a new time domain simulation software. It was a very nice project. We have some tools internally, but we want to have new tools. And then we write down some requirements. And then, it was very nice because, before, rather than starting from scratch, we say: oh, some people are perhaps—have developed some things somewhere in Europe. We find a team in Belgium that has developed something that was very good. We set up a partnership with them and then we start to develop something that we call Eurostag.

Patrick Panciatici (00:06:20):

There were very nice features. There is a kind of language to describe all the control, and there is a very advanced time domain—numerical scheme to integrate equation with a variable step size algorithm that are very nice. And it was very interesting to collaborate with these people because it was the kind of—it was not one team; it was two teams that are interacting. We were working together, but we were to write a lot of documents, and to convince them to develop some parts, and they were testing what we are doing, and vice versa. It was very interesting. There is some kind of quality due to this kind of relationship between the two teams. It was very interesting.

Daniel Molzahn (00:07:04):

What was your team within EDF, I suppose, at this time, was it an R&D group?

Patrick Panciatici (00:07:07):

Yes, of course. It was R&D group. I learned a lot on the modeling of the system, doing that. We need to have the model of everything, from the synchronous machine, all the AVR-PSS, speed governor, even turbine, and we brought before turbine of what happened in nuclear, coal.

Patrick Panciatici (00:07:29):

Hydro is the same. All the protection, all the controls. I learned a lot on the modeling of the system because I need to have the equation and everything. It was a very nice value that— And then we developed that for many years with them. I started as an engineer in this team, and then I became project leader for that, after five years, I think. And then I moved to another topic. In France for a long time, we have this secondary voltage control. We have something that controls the voltage at the substation of the, for example, the nuclear power plant. We have four, three, synchronous machines, and we control the voltage at the connection point on the SI voltage level. And we have that since, I don't know, '70-something.

Patrick Panciatici (00:08:26):

We have a project to improve that because we want to have something that is a bit more, a bit faster because it was not possible to do something locally with no model of the rest that go fast enough. When we have the peak hour, there is not enough—the reactive power that the generating unit can deliver was not fast enough. We have some kind of—the voltage was not controlled during the, during the ramping of the consumption. We want to have something that was faster. It was impossible to have a model that was just local. We need to have some interaction with the neighboring nuclear plants. We call it coordinated secondary voltage control. So I arrived in the project, everything was fine in simulation.

Patrick Panciatici (00:09:23):

And my objective was to do that for real, in the control room—in the regional control in the western part of France where we have a lot of voltage problem. I did this job, something that kind of—simulation engine, and then I need to extract controller and to put it in a kind of real time simulation—real time framework to put it at the controller in the control room. I did a lot of IT, not a lot of control, everything was design. We simplify a bit, design, because it was too complex. It was kind of MPC, but just a one-step MPC. And so, it was an optimization, in fact, in the loop. It was an <inaudible> operation. And then there is an optimization engine, and of course there is some feasibility problems sometimes.

Patrick Panciatici (00:10:19):

We have to relax some constraints. So, I did some tuning around that, but not a lot of theory, but I did a lot of tests, and I did something that was in—now when I think, it was really incredible. I integrated everything in a lab. At this time in EDF, we have a lab with small synchronous machine. We have six of them. We are possible—a virtual line with resistance, capacitor, and inductor. We can create a small network. And we have all the real AVR/PSS on this small synchronous machine and this real speed governor. And then I integrate this simulated voltage control on top of that—using the right interface, the same kind of communication, everything in this lab. I put in the workstation, a workstation with the algorithms that are running in the control center that sends the order through this long distance.

Sairaj Dhople (00:11:26):

So just so we are clear, these were physical machines?

Patrick Panciatici (00:11:29):

Yes.

Sairaj Dhople (00:11:30):

And they were scaled down.

Patrick Panciatici (00:11:33):

One, one kilo—. One kilowatt.

Sairaj Dhople (00:11:35):

Okay. Roughly, what is this the scaling factor that that represents?

Patrick Panciatici (00:11:40):

Thousand? It was one gigawatt.

Sairaj Dhople (00:11:44):

And the six machines represented the six largest generators?

Patrick Panciatici (00:11:47):

No, it was the same. It was just to prove the concept that implementing the real control we have—

Sairaj Dhople (00:11:54):

Got it.

Patrick Panciatici (00:11:54):

It's not to prove that the thing was working, it's more to test the real implementation. It was more kind of IT test. And we debug so much, things on the communication, on the communication at this time. The communication was a, kind of, it was not TCP/IP. It was something before that. It was a nightmare. And I have a lot of different protocols that—different protocol—modbus, things like that. And we have also some kind of new sensors, some kind of PMU, also, because we need something that was more accurate. But we have PMU. We integrated everything in this lab, and we debug the communication. And—

Sairaj Dhople (00:12:38):

So, this testbed, was there a reason why this was physical machines versus a computer?

Patrick Panciatici (00:12:44):

No, because we had that. We are used to have this microgrid, as it was called "microgrid." Yes. Because it was micro compared to the big one. We are used to testing before going in the field in this lab.

Daniel Molzahn (00:13:01):

So, this had been done for a long time?

Patrick Panciatici (00:13:04):

Yes, but I was the last one that used this one. And then they shut down everything because it was too expensive. And you need to have very good technical people that are able to connect things, and you know, it was very difficult to maintain these people. And then they said, "oh, we have to move to digital simulation and get rid of this very expensive stuff."

Sairaj Dhople (00:13:24):

What year was this?

Patrick Panciatici (00:13:25):

Hmm?

Sairaj Dhople (00:13:25):

What year was this?

Patrick Panciatici (00:13:27):

It was—I don't know, '90, '96-7, something like that.

Sairaj Dhople (00:13:37):

Do you miss that lab? Do you feel like computers are better at simulating the phenomena?

Patrick Panciatici (00:13:41):

No, we need both. I think we need digital simulation, but at the end we need to test with this mockup, because— I can explain something on adaptive control. That's also interesting. It was not exactly my project, but I was attracted by these people from adaptive control, so I was following what they were doing, but it was not exactly my task, but—I was very excited by that. It was so magic. You're doing nothing, just a measurement. So, the people want to do that now, and they do everything. They identify the model, they have the optimal control in the loop, and then they send the right order. So, in simulation it was, everything was okay. When we test that in this micro lab, it was impossible to do something. It was completely unstable. That took them some time to understand why, and they understood that it was a non-minimum phase behavior that they don't have in the digital simulation, and they are in the small machines.

Patrick Panciatici (00:14:38):

And perhaps it was a fictitious non-minimum phase, perhaps in the big one, perhaps it's not the case. But anyway, we don't know, we don't know. But in this case, there was this problem, and they say: wow, we don't want to do that. We don't know, perhaps, but you know, because when you write the equation, even in time domain sometimes non-minimum phase, it's something that is so small, we don't care so much. But yes, in this case it was to try to inverse a bit this transfer function, to find the optimal controller. So, the zero becomes some pole, and then you are in trouble. It was very interesting for me to see that at the end, it's not bad to have this kind of mockup. But nobody wrote down the equation. This was a bit on the side. It was not exactly my job, but I was following that.

Sairaj Dhople (00:15:32):

Were there other similar test beds of this type in EDF where they tested other algorithms in the past?

Patrick Panciatici (00:15:38):

In the past, yes. Algorithms—more of this control.

Sairaj Dhople (00:15:41):

Yeah.

Patrick Panciatici (00:15:41):

More control and protection. And even this sub-synchronous, for example, possible oscillation between the HVDC and this big synchronous machine, we—,

Sairaj Dhople (00:15:52):

So, building physical prototypes, scaled-down versions, was a common practice?

Patrick Panciatici (00:15:55):

Yes. For example, they did crazy stuff to replicate the tortional stuff. These people was very good in doing something that tried to mimic the real system. We have a lab with a small HVDC system, then we try to understand it, this lab, this possible, sub-synchronous oscillation.

Daniel Molzahn (00:16:21):

So, this was the expectation for any controller you build, is that you do hardware tests?

Patrick Panciatici (00:16:22):

At this time, yes. We simulate with digital simulation. And this time it was not easy, because computation is also the motivation because we know that it was very difficult to do a very nice digital simulation because of the limited computational capacity we have. And then we go to that and then it was, I think it was a good idea and it's still a good idea, but okay. So yes, but it was not exactly my job. But I was the last that used this lab. Then it closed down. And I did something a bit crazy at—because I—at CIGRE I have a demonstration—and you know, CIGRE is in Porte Maillot, so it's quite far from EDF. And at this time in '86, I was able to have an internet connection, and I was able to connect from CIGRE to this lab, and to have the control of this machine in the stand at CIGRE.

Daniel Molzahn (00:17:19):

Ah, okay.

Patrick Panciatici (00:17:19):

It was fun for me to organize that, to find the IT internet provider at this time to do that. It was difficult for the people to understand that I'm not doing something real. I have some cameras in the lab. But it was fun for me to—it was very interesting for me to understand that it was possible to do that. It was the very beginning of internet because it was very interesting.

Brian Johnson (00:17:42):

Patrick, were you able to successfully demonstrate that voltage control method on the actual nuclear plant?

Patrick Panciatici (00:17:48):

Then, yes. We did that in the lab and then we go in the field. I spent, I don't know, I went—yeah, we have a very progressive test of everything. I was going—It was in Brittany, in Nantes. It's a big—two hours with high-speed train from Paris. I was there one day by week to do some tests. And then we installed everything and then I spent a lot of time in control room. It was nice. I interact with real people, and real operators, and I have a lot of interesting story about that. But you know, this time, the protocol was very—very easy to do something. I can do whatever I want. I want to—the internet connection—and connect and disconnect everything. I put a new computer somewhere.

Patrick Panciatici (00:18:43):

I was part of the staff, and I was able to do whatever I wanted, and I had a lot of freedom to—it was very nice. And then we have some interaction with nuclear power plant to start some tests. I spent some nights, because he had to have the ramp-up during the morning and, it was nice to spend some time in this control room with the people, to understand. And to explain what we're doing. And then to explain that now we have something that is very fast. You don't have to play too much with the set point or the voltage. So, you can have something that is very flat. But of course, there is some counterpart that you know, for the voltage collapse, for example, we have something that is very optimal.

Patrick Panciatici (00:19:25):

Then, when you exhaust the reactive power: boom, you go down. The voltage is very flat until you go down. It's impossible to monitor the voltage to test the proximity to the collapse. You need to monitor the reactive margin of all the generating units. We develop also something to monitor the reactive margin. And there was a very small algorithm that are very nice, because it was possible using this reactive margin to switch on capacitor bank to restore some reactive margin to be used by this cross-loop controller. It was very easy, and it was a kind of tertiary level connected to the secondary level that switched on the capacitor bank.

Daniel Molzahn (00:20:11):

So, the model predictive controller was doing both? It was running the excitor?

Patrick Panciatici (00:20:16):

No, there is two.

Daniel Molzahn (00:20:17):

It was a two-level?

Patrick Panciatici (00:20:17):

Two level. There is something, and then we're monitoring the reactive margin. And when it's not enough, we are connecting capacitor bank where the voltage is very low. It was very easy. And then that restores some dynamic capacity, and then in case of problem, the other one has some head room to, to click.

Daniel Molzahn (00:20:40):

So, was that automatic?

Patrick Panciatici (00:20:41):

Yes.

Daniel Molzahn (00:20:42):

The whole thing was?

Patrick Panciatici (00:20:43):

Yeah. It was very nice. And we developed that, and that remained in operations till, for, they just stopped this, I think, six months ago.

Daniel Molzahn ([00:20:54](#)):

Oh, okay.

Patrick Panciatici ([00:20:54](#)):

We were never able to deploy that for all the regions in France because it was a bit costly. And then also it was the splitting between EDF and RTE. We need to define a new kind of ancillary services and—. nobody wanted to upgrade a nuclear power plant. You need to put something in nuclear power plant. It was not a lot, but you need to change something. And then, you know, in integrated company it was a bit, it was an internal project, so everything was okay. But now it was split, so then it was impossible to deploy that in the rest of the region.

Patrick Panciatici ([00:21:35](#)):

And, now they stop and, okay. But I'm a bit confused about that. But anyway, we will see. They can't remember why we did that in the past: because we have to have a faster control, so we come back to the old one, but we need to slow down the controller. Okay, we'll see. I did that. It was very interesting, and I have lot of interaction with the real people in the control room. And I have a very interesting—I don't want to joke about that. Anyway, then I moved more to this EMS business for contingency analysis. I was project leader for that. But it was a very small team, you know, it was very interesting. We are only—in R&D we are not able to manage very large teams. Four people is okay. More, it's a mess. We were always this kind of small team, four, five, no more than that, doing everything. It was very, kind of, startup thing. It was very interesting. And so, I moved to this more, this contingency analysis EMS topic. I was more team manager on that.

Daniel Molzahn ([00:22:58](#)):

Do you know what date it was?

Patrick Panciatici ([00:23:00](#)):

I don't know, '80, '90-'99 or something, something like that. 1999-2000, something like that. At this time, we have a—when we started this, we have eight control centers, seven regional and one national. We have a team for day-ahead, we have a team for planning, and they're using all different tools and, even between day-ahead and real time, they're not using the same tools, the same data. They—there's always some problem because the day-ahead says something and then they're not able to replicate that in real time. They are doing something that is completely wrong. It was very difficult to have some exchange between the different teams that are more the operational planning and real time. And also between the planners and even expansion planning. They're using another kind of model. They plan the system, and then when they build something, the operational people say, “we don't need this line.”

Patrick Panciatici (00:24:09):

They did that. “We know how to manage that, because we can do some switching or something.” But the people were not aware because they're using, for example, just the bus-branch model for the planning, for the expansion planning, and the other one using a more node-break. And they're used to do something very smart using topology change. And the other was not aware of that. Then we set up a big project that we call convergence, to try to use the same tools and the same data for all the company. And it was a very interesting step-by-step process. We begin to, by managing the data more and to keep the tool a bit different, and then we create something that is more kind of data management and to create some snapshots.

Patrick Panciatici (00:24:57):

We merge all the—because we have state estimation on all the SCADA, and then we have something at national level, but it was not accurate enough, it was just SRI voltage. We do some kind of merging of the snapshot to perform a new kind of state estimation, merging the result of the other snapshot to have a big snapshot of all the French system. Then we developed a lot of things on this data management to provide some possible—when you are planning the system, you try to change some assumptions on the load and everything. We develop some kind of environment to have this workflow to say: “okay, I'm starting from this date and then I change the load in some region, and we have some possibility on all that to create a new base case starting from the, some weird case.”

Patrick Panciatici (00:25:50):

It was a very nice first step. And then we merged two or more to use the same tools. It was not very advanced. We use the tools that we have. But we select one, which, we just improved this one, and then we use the same for all the company. And it was a long project and then—I'm very proud of that. Now we're using a single tool for all the company—and the planners are able to see the snapshot that occurred five minutes ago, even planning the system for 10 years. And they can see the very last snapshot. They can run all the tools. We have a very big environment now. We have everything in two data centers, even if many different control centers, all are using the same data, the same tools in two data centers. I'm very proud of that.

Daniel Molzahn (00:26:45):

From what I understand, all these tools are built in-house. Right? Round out your—

Patrick Panciatici (00:26:51):

Yes, yes.

Daniel Molzahn (00:26:51):

What was the decision? You could have used external software or other people's software. When was the decision made to do that? And was that, you know, controversial or —

Patrick Panciatici (00:27:02):

No, it was not. It was a DNA of the company to—we want to see what inside the tool, also to be independent for any vendors, to be able to change and to understand or even to— We know that we need some heuristic and approximation, but we want to know the heuristic and approximation. And we know that there is some open problem that is something it is impossible to solve, and it's good to have heuristic, but we want to know the heuristic. When we go to some commercial tools, they won't explain what they're doing, we don't think that they are doing, a bad job, but we want to know. And perhaps we're doing something that is not better than what they're doing, but at least we know what we're doing. Perhaps we can improve because we know that something is not very good. We're not very proud of that. We do that.

Daniel Molzahn (00:27:57):

So, this convergence, would this have been possible without this project on getting end-to-end snapshots down from the day-ahead to the real time to the planners. Would that have been possible without that or, it sort of seems somewhat unique to RTE? Is that the case?

Patrick Panciatici (00:28:14):

Yes, I think so. Still very unique. Except in China, perhaps. State Grid of China is doing something very similar. But everything integrated with some team internally that I developed.

Patrick Panciatici (00:28:28):

So yes, I did that. And then in this project there was something also very interesting that—we saw that we need more coordination at the European level. And we say: “okay, you know, we have a market that is more on the European level, and we need to do something at the European level.” And of course, it was impossible to set up an ISO at European level. It would be politically impossible to find a leader for that. And we have a model in mind to say: “okay, perhaps we can do something that is more kind of a coordination center, that gives advice to the national control center.” It's not a hierarchical system, it's something that gives services to analyze the security of the system and provide perhaps some possible remedial actions. And then we said: “okay, we need to develop some tools for this control center that was not existing.” So, in this project convergence we also developed something that could be useful for this coordination center that didn't exist yet. And we were waiting for an opportunity. And then the Germans in 2006 did the mistake that we had the splitting of Europe and everything.

Patrick Panciatici (00:29:41):

And then: “yeah, yeah, we need more coordination, and we need to set up something.” And then say: “we have some tools and—.” But we were prepared since the very beginning of this project, because sometime in Belgium—Belgium is north of France and connected with Germany and Netherlands, and there are some loop flows and they're not able to control anything. So, they were very afraid of this loop flow. And then we said: “yes, we need more coordination, we need to have some tools, we need to try to assess for this loop flow or not in day-ahead or something.” And then we developed something based on some kind of model we have in Europe that is a very old format, but at least it was a possible format to exchange data. We develop a lot of—always import, export—translator for any format. And we got a lot of creation data.

Sairaj Dhople (00:30:29):

You referenced an event in 2006? Can you explain a little bit more about what happened there?

Patrick Panciatici (00:30:33):

Yes. It was in Germany. There is a shipyard in the river in the north of Germany. When the ship is finished, they need to go to sea, but they need to go—there is a high-voltage line, and they need to shut down the current when the ship is going below the line. And they plan that in day-ahead, and then make some computations: "Okay, normally at this time of the day, there is no problem. We can open, we can switch off the line and there's no problem." But then, I think I can remember, yes, the ship came a bit before this time, and they never recomputed anything. And then they open the line and there is another load somewhere, in Germany, and someone made a mistake. He wanted to do some switching to avoid the overload.

Patrick Panciatici (00:31:28):

And he did exactly the reverse. He did something that was completely wrong and then everything: Wow! There is this old weak border between the East and West Germany that is still a bit there. So, everything open is in a very old historical border between East and West Germany. And on the West, we have a lack of generation. In the East there is a surplus. We have some load shedding in France and everywhere, 20% of load shedding. The problem was not a blackout, but we load shed, 20% of the load for half an hour or something. And on the East, it was even more difficult to manage because there was this over-generation, and there's some wind in the north of Germany, in the East. And they tried to do something and at the beginning, some wind farm trips, because of the high frequency, but as soon as the frequency comes back to normal, they connect again. It was very hard for them. And then we were able to synchronize, I don't know why. It was a kind of—people try many times to synchronize again. And at the end they were able to do that. It was again: Wow! And then that lasted, not for long, but it was very close to blackout in the East, and we load shed 20% of the load in France.

Sairaj Dhople (00:32:55):

Was that the most stressful time that you have seen in your career in terms of the potential of a large blackout or have you seen—

Patrick Panciatici (00:33:03):

No, we are very afraid of some voltage problem in Brittany, because we have a peninsula. In France it's called Brittany, across to UK. And there is no power. There is no generating unit. That one is very—at the beginning of the peninsula. And so, we can have a voltage problem, and we are afraid of the collapse. We have a lot of nuclear power plants along the Rhone River. And if the voltage collapses, this will trip and trip and trip and trip and we don't know what—cascading failure. We were very aware, very afraid of that. We developed some kind of new load shedding based on voltage. Also, event based—when we lose the last generating unit, we load shed some load in this peninsula.

Patrick Panciatici ([00:33:53](00:33:53)):

And it was something that was a bit strange because, we need to do something, we have just one year to develop this project, and we need to use what we have. It was not possible, for example, to put in sensors. And I remember, this time it was very interesting because the top management of RTE was very technical. And we show that with the measurement we have, we can have one second of delays. Perhaps, depending on the load model, it was not possible to save the system. So, depending on the—note the alpha/beta that's in the model. And then you say, "okay, we don't know this value." If alpha is more than one, it's okay, but if it's one, it's not okay. So what can we do? With one second, it's not possible to do something even with load shedding. Okay. But is it possible to speak with the top management about this alpha? <Laughter> No. So you have a joke. Okay. Depending on the value of this alpha, I will go in jail or not. <laughter> Okay.

Daniel Molzahn ([00:35:04](00:35:04)):

But just to be clear, you're talking about the parameters of the ZIP model? Right?

Patrick Panciatici ([00:35:07](00:35:07)):

Yes.

Sutanwi Chatterjee ([00:35:12](00:35:12)):

So how can you explain this particular thing to the general public?

Patrick Panciatici ([00:35:17](00:35:17)):

So, you know the load model? For this stability problem, this long-term stability problem, there is a kind of impact of the load. The load is not constant power. It's something that, depending on voltage, and the sensitivity of the voltage, is kind of exponential—model with some exponential. Alpha—and depending on this alpha—if alpha equals zero, it is very difficult. If alpha equals two it's okay. And we don't know exactly, it's depending very much on what the people are doing. If there are—air conditioning, some motors—it's not the same. There is some resistive load, it's not the same. And we never know exactly.

And it’s changing over time, during the night. And day is not the same. We need to have a model to assess something, but we know that a good model doesn’t exist for changing all the time.

Patrick Panciatici (00:36:14):

And we don't know exactly the parameter. But depending on the parameter, we can save the system, or not, with this kind of protection system to avoid this cascading failure. And so, everything was depending on this value that we don't know. To understand that and at this time it was possible to speak up with top management about that. Now I think it could be difficult. Yeah. It was fun. It was fun, but it was R&D. From the R&D we develop everything like that. And in a very short time. But of course, we have also background to understand that. We're not starting from scratch on this problem. We were aware of this voltage collapse, we were aware of the impact of the load modeling on that. But we developed something very fast to—

Daniel Molzahn (00:37:11):

What was the—? You mentioned a deadline of a year. Was that, just management said, we have to have this fixed in a year, or was there something externally happening that, you know—

Patrick Panciatici (00:37:21):

No, we stopped—the very last generating unit stopped. There was some coal-fired—stopped. Then we have less and less generating units. We are afraid for the winter, because when we have a lot of load on the eastern side of the peninsula, we're afraid of voltage collapse. And then if, and we're afraid of these cascading failures, then if we start all the nuclear power plant from the Rhone River, we trip, and then we don't know what could happen. We can have European blackout. Even the French blackout is not good, but European blackout is even worse. And then perhaps, and because of nuclear power plants, because they are very sensitive to the voltage, because we have all this auxiliary stuff that are big, synchronous, asynchronous models and they need some voltage to run. So people would be against more nuclear power plants. Some kind of concern about that. It was very intense to develop that. It was very—and also, we have to have a very technical discussion. It was intense and very, yeah—.

Sairaj Dhople (00:38:35):

So, it sounds like you are excited about research and development and innovation, but at the same time, your position puts you at tremendous pressure in terms of keeping the lights on.

Patrick Panciatici (00:38:43):

Yeah.

Sairaj Dhople (00:38:44):

How do you balance that risk versus reward in your career?

Patrick Panciatici (00:38:51):

You know what we are doing is more kind of—of course the operational people are taking care of the system for normal operation of the things that are—we're used to. And the R&D is more when they're not able to understand or they need—. It's an interesting position because it was something—and the people from R&D love that—to be involved in something that is very useful and that you see the impact. Because you know something. And perhaps I have something on the connection with Ukraine, for example, that it was also the case that we did recently. I can explain a bit later on that. This idea that we are preparing something, we're very strong on the foundation, and then when we are trying to solve very complex problem.

Patrick Panciatici (00:39:43):

And then when the problem arrives, we are ready to help the company. But of course, yes, sometimes you need to be prepared, and there is some kind of investment on the scheme and on the fact that you perform a lot of time-domain simulation. So, you try to understand the model and normally it's okay. You don't need all this detail, and you don't care, you know? But when we reach some limit, then nobody understands something, and then they go to there, and they say: “you need to help us.” I think with the problem in Germany, we were preparing something to create this coordination center, and we were waiting for the right time to say it. Because the need of coordination was not obvious for many people.

Patrick Panciatici (00:40:36):

We need to find an event and then to say, okay, now we understand that we need some coordination. And of course, for a variety of reasons it was so obvious for us that we need something, but we need some evidence. And then after that, yes, we have some kind of evidence that we need more coordination, and we have this idea of this coordination center and some tools, that we're able to deploy in this coordination center to do the job. To be prepared for something. And, you know, it's very difficult for the operations people when we go, it's never the right time for them. It's too early or too late.

Patrick Panciatici (00:41:11):

Because they are managing the system now. They don't see any problem and then sometimes say: “yes, we need something, yes, tomorrow.” But just: “I need to think about that, you know, I don't have the solution, but do you think it's a real problem?” “Yes, yes, yes, I need a solution tomorrow.” And some other case: “oh, we don't care, you know, this grid-forming, nobody cares.” This kind of thing. We did something on convergence from this coordination center for Europe with the tools. That was very interesting. And then in 2003, we were still in EDF R&D working for this part of the company that was RTE, that—we are split in 2000, but in 2003 it was too much. We were in EDF R&D, it was impossible to do something for RTE from EDF because we have this unbundling.

Patrick Panciatici (00:42:05):

And so, we say: “okay, now we have to do something because we must go to RTE or to stop work for RTE because, you can see we want to do something more on the strategy.” And then something that—it is not possible for RTE to share ideas about that with EDF. We say, “oh, we stop, or we go to RTE.” And it was a funny, very interesting time because we create this internal R&D in RTE. And it was very interesting because it was a small, it was—we go for—80 people that moved from EDF R&D to RTE. And it was very nice. I bring a lot of energy in this team, it's kind of a creation of something new, and there was a lot of motivation in the team.

Patrick Panciatici (00:42:56):

And also, we connect even more with the top management of RTE, because we are very close. Because EDF was a big company, so to go normally to make the decision, we've got to go from the R&D to go up and down to RTE. But we merged with RTE, so the decision making was very rational. So in 2003 we did that. And this is why in 2006, after the incident, we are able to make this kind of decision to develop this coordination center too. I think it would be impossible to do that from the EDF because decision making is too long. We lose critical mass for the EDF R&D, because it was more than 2,000 people in R&D division. With 80 people, they were working on everything, nuclear and everything. Not only power or on transmission, but—so it was nice, it was very nice.

Patrick Panciatici (00:43:56):

I was a leader on creation of that. And also, we say: "okay, we want to have some IT solutions that are just for us. We don't want to use the IT, the corporate IT solution. We want to be free to use whatever we want— software—we can install whatever we want." We have this dedicated IT system for us. It was very nice too. Then yes, I continue to be this leader of EMS team, and I become a scientific advisor in R&D doing more stuff, connecting people in the academic world to interact more, applying mathematics stuff, optimization, everything. But more the kind of "scientific advisor" than doing myself a lot of R&D but pushing to connect to the best people in the world.

Brian Johnson (00:45:04):

Patrick, I have a question. Can you comment on what it's like to be running a power system, where you guys have to coordinate and work together with so many other countries, where I assume that they each have their own ways of doing things, and somehow everything has to still work together?

Patrick Panciatici (00:45:21):

Yes. So in Europe for a very long time, we have kind of organization that was called UCTE and then ETSO and then ENTSO-E that try to—at the beginning it was more some kind of club that we exchange some good practice—but that became more and more binding. We define more and more rules for everything. And I think we are aware of the interdependence on all the system, you know. In operation when you call your neighbors and say I'm in trouble, they're not negotiating a lot of money or something. They're afraid. We are big, so if we fail, we can lose the black hole of Europe. We have a lot of solidarity on technical things, on the real-time and everything.

Patrick Panciatici (00:46:12):

But of course, we have some standards that are not exactly the same and sometimes a bit ridiculous. For example, in Spain and France, for critical clearing times, they say: "okay, we want to have critical clearing time down to 250 milliseconds." If we're doing that in France, we stop all the nuclear power plants. But it's very close to the border. So, some funny thing like that. And for this internal model, we need a lot of coordination and it's still not very clear what we can do on that. But we push more. For example, I can say something on Ukraine. It was very nice because we have this request from Ukraine for a long time to be connected to the West.

Patrick Panciatici (00:47:03):

Normally it's a process, they have to be islanded for one year to show that their system is good enough. And we have to assess many things before connecting them. Once they start to be islanded from Russia, two days after the war started, they want to be connected. But we need to do a lot of, normally, study and everything, but of course it's not done. We said: “okay, we need to connect them. We need to do that.” And then they call us and say, “what do you think? Well, what is—what are the risks?” And we don't know, perhaps we can have inter-oscillation. We don't know, we never assessed that. And so, what we can do, we can monitor more the PMU and everything. We can connect but monitoring more the PMU in real time to see what happens. And then we create a working group in Europe to exchange more, because we have some PMU, not a lot, but now we exchange all the PMU for all the TSO and we're able to assess more this mode.

Patrick Panciatici (00:48:10):

That boosted a lot the exchange of information to monitor this possible oscillation with Ukraine. And once again, we had prepared some tools with Professor Manny from Washington State University. We tested this tool. It was very good. But the people in RTE were: “we don't need that; we never have some kind of inter-oscillation.” But we were able to deploy this tool very quickly. And then we organized for, I don't know, two months, the 24-hour monitoring. And the R&D team was involved in that. We developed some—myself, I participate in monitoring, because we are actually shifting and then we monitor a bit, all this inter-oscillation, and nothing happened. It's okay. And we have a variety of network conditions. But it was very interesting to—and we have this coordination, for ENTSO-E, we each have more PMUs.

Patrick Panciatici (00:49:10):

But there is a general thinking that we need some event to coordinate or to polarize or catalyze, I don't know. You need to be prepared to—this is a general idea of how R&D could work. So, you're preparing something and then you're waiting for the right moment to deploy. Because if you—okay, so this is something interesting. I think as I said, Ukraine connection, yes. This is various things that I did. And then I'm involved in many, many, many, many organizations. In US, in PSERC, with Stanford in <inaudible>, and in Europe, in many European projects in the past. And now, more at the beginning, how to create consortium, how to find a good partner, more at the very beginning of the project. Now, after that, I'm not following too much, a bit some project, but not too much. So, yeah.

Julie Cohn (00:50:15):

So, in your R&D group, do you try to imagine things that haven't happened yet?

Patrick Panciatici (00:50:24):

Yes, every time.

Julie Cohn (00:50:24):

How broad is—

Patrick Panciatici (00:50:25):

At the coffee break! The coffee break! Yes. For example, the first time we—grid-forming, stuff like that—say: "okay, now we have this grid-following, if nobody creates the frequency, what would happen?" <inaudible> Thibault on the coffee break. "Well yes, we need to do something." And then I say, "okay, what we can do?" so Thibault went to Georgia Tech with Sakis, and then Brian was doing something. We begin to read on this. Some people believe that we do, we do not. And then we start to work on that, very early, in 2011, I think. It was very early compared to now—all the people are speaking about that. But we start quite early, and I think only Brian was working a bit on that.

Brian Johnson (00:51:16):

A few of us.

Patrick Panciatici (00:51:16):

Yeah. But not a lot of people.

Sairaj Dhople (00:51:20):

But somehow in your coffee break, you couldn't predict the German ship going—

Patrick Panciatici (00:51:24):

No, no. But we're waiting for that to promote the coordination. We're hoping, not predicting, a mistake somewhere. I can't remember exactly this question.

Julie Cohn (00:51:46):

Well, I was just curious about how big the imagination has to be in a research and development group. A little different from the planning group, of course, that probably says: "well, this is the range of things that could happen in the future, but we're going to throw out the high and the low and plan for something slight, a slightly less broad band of possibilities." And living in Texas, I think of the outage in 2021 as an example of that. But in Europe there have been wars on the fringes of Central Europe on and off for a long time. So, is that always part of what you think about in terms of a grid that is coordinating so many countries?

Patrick Panciatici (00:52:35):

The question to interconnect more the Eastern part was something that the European Commission is pushing a lot. And there is some political will to do that. And of course it's very difficult to do some technical stuff. It's more political. Sometimes they want us to prove that it's very cost effective. It's not, you know. But I understand why you want to connect the bad country, for example, I understand why politically. But if I compute something, there's no return on this investment. I understand that you want to do that, but it's not possible for me to compute something that is—enough.

Julie Cohn (00:53:15):

Yeah.

Patrick Panciatici (00:53:15):

And even the reverse. For example, we a have connection with Ireland. They don't want a connection that goes to south of England. But of course, if you compute something, it's very efficient to do that. You can have more efficiency in the market if you have this connection with south of Ireland, or of England.

Patrick Panciatici (00:53:33):

But the Irish want to have a direct connection to the continent. Okay. I understand. But you know, it's not possible to compute anything like that. But it's interesting. What we are able to do—even the eclipse, the eclipse we had, I don't know, we have a few PV, not a lot, but some. It was the same. We were thinking of some common mode that can—some problem with the PV panel. Yes, we can have an eclipse for sure. And then we did that two years in advance. We coordinated something in ENSTO-E to assess the impact, and all the people put a large margin, primary frequency control, and everything was okay. But you know, No! The operation people are not prepared to something like that. Once again at a coffee break and we're starting on something to find some common modes that can impact the system and say "yes." But this PV panel, I don't know. Or we can have some snow for example, on the PV panel and then what happened? Then we have some sun, but the snow, the snow will take some time to go away. But we kind of—also perhaps some other common mode, but of course the eclipse, and now we have many questions about climate change and everything. So, you can create very negative scenarios, and we are very good in France to create negative scenarios.

Patrick Panciatici (00:55:01):

We can create many, many negative scenarios on—negative—everything. But sometimes it's good to be proactive. For example, we can have more dust because of the lack of rain and then this dust—we have to do something with the dust—can enter the substation. So perhaps we need to upgrade substation to put some kind of pressure inside, like we have in, more, the converter for HVDC. But that will cost something, and of course we need something that is active, so consumes some energy, so it's not very good. And the same perhaps can have some dust on the PV panel and then you need to do something to wash a PV panel. But we have no water. So, you know, we're creating this kind of crazy story, the narrative of the collapse. We're very good to do that in France: a narrative of the collapse. But then we can perhaps prepare something. I don't know.

Sutanwi Chatterjee (00:56:05):

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

Patrick Panciatici (00:56:13):

Hah. Perhaps the need of holistic vision and—you know, people. We were in steady state in power systems for many times, so then the system was a bit lazy and not very optimal. They say: "okay, perhaps it's not a bad idea to split the system in pieces to create more kind of innovation or something." But now we have a big transition. So perhaps the way we split the system, it's not the right one. And then it's very difficult to have a holistic vision for many problems. So perhaps, I don't know, we need to do something more holistically and then perhaps to split again when we reach a new steady state. But the transition, with the existing agent, is not perhaps something that is very efficient because we need to negotiate and to have contracts for everything at the end. For example, we're paying some ancillary services, but they're essential. This is like oxygen—is not possible—

Patrick Panciatici (00:57:13):

we are ready to pay all the money we have. The people believe that there is a market. Of course you can put the market on the oxygen. We need to think about, a bit more on, all this market design and everything and perhaps it's not very compatible with the energy transition and to think very holistically. And even between transmission and distribution, that becomes a bit fictitious because now they're from generating unit connecting there. It becomes a strength. And we have some contracts and the interface, and we need to put more and more complexity in the contract. It's not possible to monitor that. It's not possible even to put some value. So it's become very complex, and the lawyer takes the power on the contract, and we need to use a language that the lawyer can understand. It's a bit restrictive for engineers. But you know, holistic. Yeah, holistic, and perhaps a new organization, perhaps not integrated, but at least some more coordination in ventures, I don't know. Something that— not try to monetize everything.

Sutanwi Chatterjee (00:58:34):

Okay. So, are there any other questions anyone would like to discuss?

Daniel Molzahn (00:58:40):

Yes. One question. Going back to the beginning, you had mentioned some of the initial forecasting and controls tools that you put in place, in some cases decades ago, are starting to get maybe supplanted by new methods. So, what's your perspective on this? We've used a lot of these tools for a long time. They've been very successful, some you've made, right? Looking forward, do we have the right kind of technologies in place now where we can start making this transition, possibly away from some of these tools? Or are we sort of moving too quickly away from, replacing your load forecasting, for instance with new methodologies?

Patrick Panciatici (00:59:32):

I think yes, the system is changing so much that we need to go to something that is quite different. It's more to go to more decentralizing—edge computing. Something that, of course, it's a bit against RTE models that's very centralized. It's impossible to deal with this complexity from a central point. We need to have more of this kind of decentralized thing, and to solve locally the problem that can be solved locally, and something that could be quite automatic. People forget that in the past, it was possible to something—in the market, nothing. The control center. In the very beginning of the power system, your big, for example, turbine, hydro turbine that is more than what you need. You just put a kind of speed governor, and you are okay. No market, no control center, nothing. It's what happened also when you have a problem in a small way, you put a big backup and then you trust the speed governor and this thing is doing the job.

Patrick Panciatici (01:00:39):

There is no control center, no market, nothing. We put all the market and everything to optimize the system, but we're able to beat the system that is running, at a cost that is very high. But then we need to find a trade-off between this. We need to think more decentralized. So rather to have central point, I try, for example, to forecast everything for a central point, more to push the people to give some forecast locally, and then to aggregate, something like that. It's not so much the method. Of course we can change the method, that essentially is the same, or you can use new technology. But you know, in the end, these are not very different. It's more the fact that as complexity increases it is not possible to manage the last, I don't know, EV charger from the European control center. It will be impossible to do that. I think we need more hierarchical things, and to do tools that are more automatic and more autonomous to manage this large population of devices and control with some partial autonomy.

Patrick Panciatici (01:01:48):

They want to do something locally. And to depend not too much on the other system, for perhaps a bit, but not too much. And this is what happened with this price in market in Europe. People don't understand why in France we have to pay a price that is connected to the gas. We don't have any gas turbine. And it's the same in Norway. So a lot of hydro as the price of electricity increase, because we have this marginal cost that based on the gas, we have no gas in Norway, nearly no gas in France. And so, people say: "we don't want that." They want something else. We need to rethink a bit how to coordinate that in another way, and more decentralized. And of course we need new algorithms, you need new stuff. But it's not just an evolution of what we need in the past, it's more kind of a new kind of vision.

Patrick Panciatici (01:02:39):

Of course, we can improve what we—but once again, we know something. It's more this physics-informed stuff, machine learning and everything, and goal-oriented approximation. You know, people believe that. The things are complex, so you need to—and we need to start the decision-making process, what are the decisions we have to make? We need some tools to make these decisions as optimal as possible. But I'm not starting, I have a tool so I can solve some problems. We need to start by decision-making process. If a decision is more decentralized, so, okay. If the decision-making process is changing, we need pass new kind of tools, perhaps more automatic. And this vision that we have, this kind of layer of automatic control on top of that. We have something that is more, some human in the loop that can assist. But okay.

Daniel Molzahn (01:03:36):

Can I ask one more question?

Julie Cohn (01:03:37):

Of course.

Daniel Molzahn (01:03:39):

So, one thing that I'm always impressed with, with RTE, is how engaged, you know, really a fantastic example of engagement with the broader community, both within Europe, but also in US. And on the industry side. On the academia side. It seems like an organization that bridges lots of different communities. And so, I'm wondering what's special about RTE that allows that to happen? Is there, is that a model we can replicate elsewhere or, you look at a lot of the utility companies in the US and there's not much of an R&D group associated with them, but somehow at RTE that this is—got a long running.

Patrick Panciatici (01:04:18):

I think this was more from EDF R&D. That was the legacy from EDF R&D. We're used to interact with many people, even inside EDF R&D: people from nuclear, from control—we're used to doing that and to—RTE has become a bit more difficult, but I was educated and trained in this organization, so I'm a bit, kind of, I don't know, the last that still believe in that. It's kind of every kind of thing that I was trained by some people that believe that we need to interact with the best people and to find the right question first. But I'm afraid that is a bit over. We'll see. This is why we need to pursue, to recreate some kind of thing like that. That is quite difficult. But even if we're not an integrated company, we need to integrated R&D for the energy sector.

Patrick Panciatici (01:05:29):

The R&D must be integrated, perhaps not the company, but at least R&D. This is what I'm pushing, but it's very difficult also to create a new kind of integrated R&D for all the energy sector in France. I'm trying to do that, but it's something that, I don't know. Because we have some kind of national lab, so I was hoping to do something for this national lab, but it's not—holistic vision—and to keep the model. I think I was the very last one. I try to prepare something because I would quit, finish in two years or three years. But people say you need to write a lot of stuff and okay, but nobody read that. And also, yes, once again, all the stories are very technical.

Patrick Panciatici (01:06:31):

It's very difficult for me. I know that people don't have the basic knowledge too. But it's very difficult for me to sometimes, to understand that, because I run this business so many times that for me, it’s so obvious. In the past, my boss was so—for them it was so obvious. We never spoke of very basic stuff. Everything was in the company. Forever. We don't have to explain again, what is a speed governor, what is the frequency control? What is frequency? What is AC, what is DC? What is a thyristor? What is IGBT? All the people from the top were aware of that.

Patrick Panciatici (01:07:16):

The language was more—Now even internally we have to explain. And then we are looking to crazy methods. But that is fun. In France, we have very technical people, so I try to attract them to solve real problem, as it's not easy. And in France we have this problem because we have this big R&D in EDF, so all the applied stuff was done there. And then also in France people like theoretical stuff. There is this kind of—two things that go in one direction. It's very difficult in France to find some academic people that like to do applied stuff. Because they like theoretical stuff. And also, all applied was done, historically, inside EDF. This is why also we interact a lot with many people, even Belgium, very close to France. But we're working a lot with the Belgian people. They're more applied people. But I try to push very theoretical people in France to try to solve the real problem. But it's too easy, too complex, not exactly the same problem as the operational people, but it's not so far: too easy or too complex.

Patrick Panciatici (01:08:38):

Anyway, so—.

Sutanwi Chatterjee (01:08:40):

So thank you, really thank you for such an interesting information and it will really help the future generations to implement their future project works and it really gives them the creative ideas to think on the matters that you said. Thank you very much.

Patrick Panciatici (01:08:59):

Pleasure. My pleasure to share the stories. I have many of them.

[End of interview]