The Smart Grid: Managing Electrical Power Distribution and Use
Transcript

Part 1: The Vision for the Smart Grid

Julia Allen: Welcome to CERT's Podcast Series: Security for Business Leaders. The CERT program is part of the Software Engineering Institute, a federally-funded research and development center at Carnegie Mellon University in Pittsburgh, Pennsylvania. You can find out more about us at cert.org.

Shownotes for today's conversation are available at the podcast website.

My name is Julia Allen. I'm a senior researcher at CERT, working on operational resilience and software assurance. Today I'm pleased to welcome James Stevens, a colleague of mine, a senior researcher with CERT, who is working in the area of critical infrastructure protection. Today James and I will be talking about the digitization of electrical power distribution, sometimes referred to as the smart grid, including how it's anticipated to work and some of the related security and privacy issues. So welcome James. Really good to have you with us today.

James Stevens: Thank you very much, Julia. I'm glad to be here.

Julia Allen: So, for our listeners who really aren't that familiar, can you just give us an introduction to what is the smart grid, what it's intended to do?

James Stevens: Okay. Well, and I guess we're glad we're not starting with the hard questions first, here.

Julia Allen: Right.

James Stevens: So what is the smart grid? The smart grid is really not one particular thing. In fact, I like to use the term "vision" when I'm attempting to answer this question. And the smart grid is really a vision of the electric power infrastructure that uses technology to improve efficiency, in the short. And the exact vision for what that ends up being varies from country to country, region to region, and even from stakeholder to stakeholder. And you can look at it from the stakeholder point of view, for example, like the electric utilities want to efficiently provide reliable power. And from the customer perspective, we want economical and reliable power. And almost the general consensus now, we all want reduced environmental impact from our power sources, power resources, rather. And then the governments that sit over the top of all this want reliable, efficient, and secure delivery of power from all the entities that are involved.

Julia Allen: Is the intent that it will be used to help us kind of do load balancing of power on a national level? If there are areas that require peak usage, we can divert more power to that geographical area and that there's some way to dynamically allocate power? Is that part of the vision?

James Stevens: That is one potential implementation. I think for a lot of those things, there are places where technologies and advancement makes the sense, and in other places, they don't. I don't think you can say, "Okay, there's one particular thing we're going to do everywhere." I think it's going to be lots of different things from - and you look at it from the different perspectives again.

From at the customer level, there are going to be thing such as smart meters, that allow for things like automatic meter reading. So instead of a utility having to send someone around in a truck to find out how much electricity you use in a month, that all gets sent back over a network to the utility itself.

It can do other things, like automatic connect and disconnect. One of the expenses utilities incur nowadays is when, especially like an apartment building, where people are coming and going, you have to actually send someone there to connect the electricity back up for a given apartment or something, and then disconnect it when that person leaves and they're no longer paying bills.

Well, with the automatic, the smarter meters, you can actually do that remotely. And they can get into things such as charging different rates for electricity given the time of day or the time of use. And it reaches even further back into the customers where we can make more informed choices if the meter's telling us the price of electricity at any given time. There's a vision of smart appliances in other applications in the house that can choose – your washing machine may choose to run in the middle of the night because it can get the cheapest electricity at that given time.

And it also could allow - the utility can control the customer load, where if there is - one of the famous things people refer back to is the rolling blackouts in California where there was peak flows in the middle of the day and they had to do these rolling blackouts. Well, they can do things like the ability to turn down everybody's air conditioner by two degrees and cut off the, reduce the amount of load that's available, or the load that's necessary, so they don't have to do the rolling blackouts, and they can more equitably distribute the electricity that's available.

And you can step up a level, which you were getting to a little bit, at the distribution level. With more system automation, they can do things like selective load control. So one of the issues they have is when a blackout happens, power gets turned off to large segments because there isn't as much generation capacity available. Well, with selective load control, they can restore power to critical resources, things like the police station or the fire station first. And as more generation capacity comes back online, they can bring it back in through a more ordered fashion and in a priority fashion.

And it also allows the things like distributed generation, where a lot of companies right now use turbines to generate steam, heat, and things like that. And with the smaller level of distribution, they can actually - those systems can also produce electricity. And they have better ability to actually put that back on the grid.

Julia Allen: You know it just, it boggles my mind just listening to all the different dimensions of the potential possibilities, how we might use this. It raises a very natural question for me, which is who's in charge? I mean, when you talk about the various decisions that could be made for power outages or load balancing or turning service on and off, etc. Is there yet part of the dialogue, discussions about the governance, oversight, who the decision makers are in this kind of a complex system?

James Stevens: Yes. I mean, especially in the United States. Different countries are set up different ways of how those things are regulated. But in the United States, there are very, or fairly definitive boundaries within the grid between the transmission and generation, which is largely considered an inter-state activity. And it is regulated at the national level.

But distribution is largely considered intra-state and it is regulated at the state and regional levels. So there's, in the United States at least, there are many different bodies that sit over top of portions of the grid. But these boundaries that exist now are greatly blurred with the implementation of smart grid. It's not always clear where distribution, transmission, and generation begin anymore.

Julia Allen: In the same way that we really don't recognize boundaries with respect to the internet, I suspect this is also moving in that direction, right?

James Stevens: Exactly. And it's a big question to be asked. I mean, it has impacts on security. It has impacts on pricing. It has impact on regulation and all of the different aspects of the industry. And all of it has yet to be determined, because as we were saying earlier, the smart grid really isn't a defined thing yet. There are lots of technologies like smart meters that everybody accepts are going to be part of that. But it's really a journey. We're not there yet. They have some ideas about where they want to go. But as this gets rolled out, it changes. And exactly what that ends up being 10 years from now is probably not what we, exactly what we envision it today.

Julia Allen: Right. And like anything else, once we start using it, it will morph and change, and we'll discover new applications and new approaches that we hadn't even considered, once those kinds of tools are in our hands.

James Stevens: Exactly.

Part 2: Business Opportunities and New Choices

Julia Allen: So making this relevant to the audience for the podcast series, why is this a topic – I mean there are some obvious answers to this – but why is this a topic that business leaders in particular should be paying attention to? How might the smart grid impact their organizations?

James Stevens: Well, I think first of all, you can think about economic opportunities. It's estimated that hundreds of billions of dollars will need to be invested in the smart grid worldwide over the next several decades. And this level of investment means there are significant opportunities for individuals and even organizations that can

support the development and operation of the smart grid. And as we were talking about before, there are opportunities that will be available for innovators as well, as the system itself opens up. And that's on the economic opportunity side.

And then there's the side of the smart grid as it's deployed. We talked about some of the control of customer loads and distributed generation. There'll be economic opportunities for businesses who want to better manage their energy uses. There may be opportunities for you to choose more environmentally-friendly sources of electricity or choose to use them first if they're available. So you can choose to, "I want to buy wind energy first but if it's not available then sell me thermodynamic," or some other type of energy, coal perhaps being your last option or something like that.

Julia Allen: Right. In other words, you can really take, as you're pointing out in your example, kind of a green approach to how you consume power, even if it's a little bit more expensive, right?

James Stevens: Yes. Or if you're just all about saving money, you can not care about that and always pick a selection schedule that says give me the cheapest available source of energy at any given time. Or even operate my company so instead of working nine to five, maybe your company works the midnight shift because your energy savings are so great that you're better off not operating when all your competitors are operating, or the regular public is operating because you can enjoy significant savings by operating at a different time of night or different time of the day.

Julia Allen: I'm also reflecting on some of our operational resilience work and thinking about organizations that have huge, distributed data centers, the big internet companies, Google and Amazon and eBay. It seems to me that, and I'm sure managing electrical power is a big part of their concern in terms of ensuring availability of service. Do you see, for those type of organizations, some new considerations and ideas that this might provide?

James Stevens: From a cost-savings point of view is that every little bit of efficiency they can get out of their systems will be magnified by the savings from the smart grid side. So if it can be delivered more cheaply, and now you can save it, do an even better job of saving electricity by how you operate the systems or more efficiently operating systems, you enjoy even larger cost savings.

What we talked about actually a little bit about before, one of the things about the system automation, you get to things like priority load control and things like that. So if blackouts and other things occur, you can be at a higher level of restoration than perhaps someone else that doesn't need it. Or you can pay in, again, and it probably is going to cost money to do that. But you may be able to establish yourself because this computing center is so critical to my operations, I will pay an extra fee if I know that power will be restored to it quickly.

Part 3: Implications for Privacy and Security; the Smart Grid Maturity Model

Julia Allen: Obviously, the smart grid will have significant social and technical benefits, many of which we'll discover as we go. But I suspect there will also be some brand new security and privacy concerns and risks that require attention. Do you have any insight into what some of these might be?

James Stevens: Well, with the smart grid, we are replacing this physical infrastructure with a digital network one. And we can look to the current problems we have on the internet as a guide for the risks that we're going to need to be managed on the smart grid side. And start just from the privacy issues, where utilities will likely start gathering energy usage profiles of its customers for choosing optimum billing and things like that.

But one of those things that those profiles might reveal are your personal habits. I mean, when you turn on a television, it makes an electrical signature. You can watch the electrical power supply and know what people are doing. And it may open up sort of your activities to the power company. You can think just on a simple scenario of someone working in concert with a burglar, just saying, "Okay, this person is never home between six p.m. and six a.m.," or something like that. And then help support the optimal time to rob your home or your business.

And their replacing the meters with digital meters prevent theft opportunities to the customer side. Nowadays, it's a very dangerous activity to disconnect your meter. And you can do things like flipping it or if you leave it disconnected, not - the meter won't spin when you're using electricity. But if it's digital and networked, you may be able to connect to that and alter it without actually suffering the dangers of actually playing with electricity itself.

And if - I mean, we saw that with cable theft. It rapidly - people were willing to steal at that level. If someone develops a bug where they - and is able to implement that on the meters where people aren't charged for the electricity they're using, you could see that as being a huge problem for the utilities if that was pushed out.

Julia Allen: And what about things like, I think of our old friend patch management, patch distribution. If we've got these smart meters sitting at our homes that are clearly software enabled, what's the vision for keeping them up to date?

James Stevens: I think there are different models in play right now. I don't think they've decided on one. But I mean, if they talk about the cost savings of the smart meter, one of the ideas is that the utility doesn't have to visit the customer site. So patching and things like that would likely be remote. And when you get to that case, how do you confirm that the patch being applied to a given system is coming from the utility itself and not from some other source?

Julia Allen: Right. Like a-

James Stevens: And verify that what's there is doing what it's supposed to do.

Julia Allen: Like botnet, right?

James Stevens: Like a botnet or, I mean, you could go all the way down that, well, DDoS attacks (Distributed Denial of Service). What if someone was able to connect to that infrastructure and launch a DDos against all the smart meters? Or cause infrastructure problems all the way up to the levels of terrorism? And what if you could bring up and down, rapid collections of loads? If you collected 10,000 houses and suddenly tell the grid that they all need significant energy load, all this generations log online, and then suddenly bring it back down. And will the grid be engineered well enough to handle that kind of thing? Or those devices themselves make smart enough decisions so that those kind of impacts won't actually be - won't happen?

Julia Allen: I mean is there a, similar to some of the issues we see in other types of mobile device control, is it envisioned yet that, for example, all the software on our smart meters will be encrypted and there's some kind of a cryptographic checksum or other authentication approach before patches are installed? Or are they just not at that level of detail yet?

James Stevens: There is certainly a recognition that those are problems they have to solve. And there are efforts underway, one of the larger ones being run by NIST where they're looking at interoperability standards. And I think the - it's a strength of this going forward is that - the utilities and the other stakeholders have looked to the internet and seen lots of the problems that are there. And at least have recognized them and have started down that path of these are issues we have to deal with now, as this system is deployed and built, as opposed to throwing everything out there and then trying to deal with it after it's in place.

Julia Allen: Right. I mean, clearly, a lot of lessons learned. And in fact, there's a fundamental question I probably should have asked you at the outset, which is, is this all intended to work on and through the internet? Or is it - do you believe that it will end up being some type of independent and separate network?

James Stevens: I think it's highly likely to be a combination of things. I think there are some portions of it that probably likely will want it run over the internet. My guess is the most critical and sensitive parts will likely run over private leased-line networks or use other communication technologies. But I don't think they're going to standardize on one particular technology or the other. I think the idea is to find the ones that optimally suit the needs of the application.

Julia Allen: And you mentioned NIST. Who are some of the other major players? I know you've been working with the Department of Energy. But who are the thought leaders and the ones who are really trying to mobilize this community?

James Stevens: Well, there's lots of, if you're just watching TV on any given Sunday, you can see all the sort of public sector companies, which is IBM and all the GE and people who have something to sell are obviously active in that area. But also, the

NERC, FERC, and most all of the state and regional utility regulating bodies are taking part in working groups and actively beginning to address some of the issues, such as who's in charge or how will the management of the system be divvied up among all the regulatory bodies and things like that.

Julia Allen: Okay. So just a couple of final questions, James. I know you've been involved in a relatively new effort called the Smart Grid Maturity Model. Can you tell our listeners a little bit about this, who's involved, and how the SEI might be playing in this arena? We will be, for our listeners, we will be talking about the model in more detail in a future podcast.

James Stevens: Sure. I guess it probably makes sense to start with an explanation of what the Smart Grid Maturity Model, or SGMM, is. And the SGMM is really a management tool that an organization can use that help assess, guide, and improve their efforts towards the smart grid transformation, or its smart grid transformation. And what it does is provides the common framework with defined smart grid stages and options and defines a common vocabulary for key elements of that transformation. And it can be used to bridge the gap between an organization's smart grid strategy and its execution.

Julia Allen: Okay. And what - how did we get involved, and who are some of the players in this work?

James Stevens: The SGMM was actually initially created by the IBM Corporation, together with a group, I have to remember, the Global Intelligent Utility Network Coalition, GIUNC. And another company named APQC. And APQC is a not-for-profit, member-based research organization which is based in Texas. And as far as the SEI role goes, IBM has actually donated the SGMM's assets to the SEI so that the SEI can act as a steward for the model going forward.

And the Department of Energy's Office of Electricity Delivery and Energy Reliability is sponsoring the SEI's stewardship role. And what stewardship means is that we will be responsible going forward for governing and maintaining the model, collecting and analyzing best practices, and providing support such as documentation, education, training, and essentially acting as administrator of the model going forward.

Julia Allen: Sounds like a pretty daunting undertaking but very challenging and exciting, I would suspect.

James Stevens: It is exciting. And it's been really interesting to begin to delve into this field and begin to associate with all the different players.

Julia Allen: So James, where can our listeners learn more about the subjects we've been discussing today?

James Stevens: Well, I would point the listeners to the SEI website, and it's www.sei.cmu.edu/smartgrid.

Julia Allen: Okay. And I'll also include in the shownotes references to some of the NIST and Department of Energy sources that we've discussed today. Well James, this has been a great introduction. I really appreciate your time, your expertise, and look forward to another conversation.

James Stevens: Well thank you.