Scott Tinker (00:01):

The next on Energy Switch. We'll look at one of the most important questions in energy today, could solar and wind power the world?

Robert Bryce (00:09):

The key here is the relationship between the push for renewables and their impact on reliability. Renewables destabilize the grid.

Leia Guccione (00:19):

There's a number of studies that show that a well planned grid system with high penetrations of renewables and with modernized operations can be run incredibly reliably.

Scott Tinker (00:30):

Coming up on Energy Switch part one of, will solar and wind power our future?

Speaker (00:36):

Funding for Energy Switch was provided in part by Microsoft and by the University of Texas at Austin.

Scott Tinker (00:48):

I'm Scott Tinker and I'm an energy scientist. I work in the field, lead research, speak around the world, write articles and make films about energy. This show brings together leading experts on vital topics in energy and climate. They may have different perspectives but my goal is to learn and illuminate and bring diverging views together towards solutions. Welcome to the Energy Switch. In part one of this discussion, we'll talk about the intermittency of weather dependent resources. How we could back them up with dispatchable generation sources, with interconnection to other renewables and with batteries. The challenge is creating a reliable stable grid with the ability to serve society's needs as conventional energies have.

Scott Tinker (01:40):

Joining me today, Leia Guccione is the managing director for RMI's Carbon-Free Electricity program, leading their research and distributed energy and batteries and a former us Navy officer. Robert Bryce is an energy journalist writing frequently for major publications, author of six books on energy, a filmmaker and host of the Power Hungry podcast. On this episode of Energy Switch will solar and wind power our future? Part one. I've got a couple of great guests to look forward to the conversation. Let's just dive right in. Leia, can you explain the difference between intermittent and dispatchable electricity?

Leia Guccione (02:19):

Intermittency is when the output or aspects of the output of a generator are beyond the control of the generator operator. So the inability to control the wind as an example, is a source of intermittency, the inability to affect whether cloud cover impedes your access to sun, the flow of a river for a hydro facility. All of those things that are beyond the control of the actual generator operator are a source of intermittency.

Scott Tinker (02:52):

Yeah. So it's just not steady and it's not controllably steady, we just don't-

Leia Guccione (02:57):

Correct.

Scott Tinker (02:57):

... don't know. Good with that, do you see it the same way?

Robert Bryce (03:01):

To me, reliability means when I flip on the switch the lights come on and that's fundamental. And I think the key here is the relationship between the push for renewables and their impact on reliability. And I live in Austin, I was blacked out in February. There's no one reason why the blackouts occurred but when you look at where the money was spent in Texas in the years before the blackouts, almost all of it was spent on wind and solar that wasn't available at 2:00 AM on February 15th when my lights went out.

Scott Tinker (03:33):

Right. So reliability, can the operator control it or reliability to the consumer? What does dispatchable mean, is it different?

Leia Guccione (03:43):

Yeah. So it is in some ways exactly the reciprocal of intermittent in that the operator has control over the dispatch of its generator. And so they have the ability to directly affect the output to increase the output or decrease the output of a generator at a given time. This sort of speed of dispatchability is something that varies by technology where you have some sources like large hydro facilities which are considered dispatchable in some ways but the speed of their dispatchability is much different than a fast acting reciprocating turbine or some other technologies that are also considered dispatchable.

Scott Tinker (04:25):

Okay, depending on whether it's a nuclear reactor or a coal plant or a wind turbine or a hydro facility or other kinds of things or different timeframes?

Leia Guccione (04:33):

Exactly. And it's important to know that dispatchable resources also have their own sources of unreliability if what we're talking about is the reliability of our system. Part of what we saw in the winter storm of Texas is that many dispatchable resources, many coal plants, many gas plants because there were disruptions to their fuel supplies or their onsite fuel systems had unexpected outages and were not available to be dispatched when the grid could have benefited from their power.

Scott Tinker (05:07):

Extreme events.

Leia Guccione (05:09):

Exactly.

Scott Tinker (05:09):

How do we plan for, how do we manage them? Are there studies that show we could make a renewable system, not maybe a hundred percent but largely renewable, largely solar and wind reliable and affordable? Are there studies that counter that?

Leia Guccione (05:21):

Absolutely. There's a number of studies that show that a well planned grid system with high penetrations of renewables and with modernized operations can be run incredibly reliably. We're seeing in places like Germany, California and Australia, that the grid is operating at above 50%. And on some days even above 80% levels of renewable penetration and that system operators are using modern forecasting technologies, modern grid sensing-

Scott Tinker (05:56):

Weather forecasting.

Leia Guccione (05:58):

... weather forecasting-

Scott Tinker (05:58):

And other kinds of-

Leia Guccione (05:58):

... and modern grid control capabilities are able to handle those high levels of renewable penetration, quite seamlessly. One of the things that's common or I should say true in almost all these studies about whether or not a highly renewable system can be also highly reliable is that you need to have a diversity of resources. You need to have an interconnected system, you need to have a smart system and then you need to have modernized operating practices to support the improved reliability of that system and so there is-

Scott Tinker (06:35):

... there's interconnected, smart controls and modern practices.

Leia Guccione (06:38):

... mm-hmm (affirmative).

Robert Bryce (06:39):

Yeah. I completely disagree. I mean, I get scarcely disagree more where we've seen high penetration of renewables. We've also seen extraordinary increases in prices. Look at California, not only in this past year, blackouts in California have become an almost daily event. The price of electricity in California has gone up at a rate seven times, the average of the US as a whole. Why? Because they're pushing so much renewables into the system. Renewables destabilize the grid that's what we're seeing now in Europe, Europe is in an energy crisis. There, it's caused in large part by a headlong rush toward renewables and under investment in hydrocarbons and under investment in nuclear. Germany, now the highest, some of the highest electricity prices in the world after their efforts to implement the energy vendor. South

Australia, again, soaring electricity prices because of this effort to push too much renewables into the system too quickly.

Robert Bryce (07:34):

I brought one line, I want to quote from it because to me it's really remarkable. Ben Fowke who is the CEO now, the X CEO of Xcel Energy in March of 2021, he testified before the Senate Environment and Public Works committee he said, "At higher levels of intermittent renewables, the cost of the energy system begins to skyrocket and its reliability degrades." Now, this is from the CEO of a large utility that is pledged toward net zero. Now, why would he say that in testimony before the Senate if it wasn't true? I have solar panels on the roof of my house, renewables have a place but what we're already seeing around the world is that as renewables increase their percentage of the share of generation, they're destabilizing the grid and increasing costs.

Leia Guccione (08:16):

Yeah. I would take issue with that, Robert, because when we look at... If we take just in the last 12 months alone, the most significant major blackout events that we've seen here in the United States and also to a certain degree in other major modern grids like Europe and then we start to do what we would call a root cause analysis of the failures on the system, all of them have actually, been more so attributed to failures in the fossil generators, underperforming or disruptions in the fossil fuel supply. So if we take-

Scott Tinker (08:52):

What were they caused by?

Leia Guccione (08:55):

... by a variety of factors. Right now, what we're seeing play out in Europe is disruptions in the price and availability of coal, oil and gas and that's causing major disruptions.

Scott Tinker (09:07):

So fuel supply issues?

Leia Guccione (09:08):

So you're having fuel supply issues. When you look at some of the blackouts and brownouts that occurred in California, it was because of under performance and failures of gas generators that happened to coincide with climatic events so very significant heat events at the same time. And these dispatchable resources in particular, the gas generators weren't available to perform as the system operators had planned for them.

Scott Tinker (09:37):

Interesting.

Leia Guccione (09:37):

Similar things happened when you look at the winter storm that affected Texas, they had slightly below average performance from the wind and solar on the system but significantly below average performance from the coal, nuclear and gas plant.

Scott Tinker (09:53):

I know the data there pretty, in the blackout times certainly, everything went down from Feb 15 for several days. I think important though, prior to that for the week from 7th to Valentine's day actually, natural gas was the only thing that rose day on day almost 70% of its normal demand in the winter. But you looked to where it fell it was actually, higher than a normal winter. So I think that the timing matters of things too as we look at grid stability.

Robert Bryce (10:21):

The timing matters a lot. And the problem with renewables is that they will produce energy when energy isn't in high demand. And that's exactly what we saw at 2:00 AM on February 15th of 2021 when my lights went out. I live in Central Austin, they stayed off for 45 hours. Well, the amount of power available at that moment was effectively zero, all that wind and solar went to Cancun with Ted Cruz who just wasn't available.

Leia Guccione (10:46):

Well-

Robert Bryce (10:47):

So this idea that the thermal generation is to blame, no. What were the assets that performed best during winter storm Uri? It was the assets that had fuel on site, it was the coal and nuclear plants. So when you look at that, you mentioned that the days before the blackout, wind did great on about January 31st when was a nice day and wind even backs out natural gas and it even backs out some coal but it was completely unavailable at the moment of crisis and that's the critical issue for reliability. Why are we spending so much money on generation assets that we can't depend on when the chips are down?

Leia Guccione (11:22):

... it's interesting that you bring up those specific points though, Robert, because when you look at the data that ERCOT the system operator in Texas reported while yes, there are a number of generators that had fuel on site that were able to continue operating. You also had a number of coal plants that had frozen coal piles-

Robert Bryce (11:40):

Fair point.

Leia Guccione (11:41):

... and had to shut down. You had several nuclear facilities because of the extreme cold temperatures, they had problems with their cooling systems and had to shut down for safety reasons. The other thing about your point about that investment in solar and wind is Texas has a competitive market and so it's been private investors who see an economic opportunity to do so.

Robert Bryce (12:02):

Well, and that's a fair point and I'll grant you that but why was that much money spent? Because the Federal tax incentives for solar, for instance in 2018, 250 times greater than what was given to nuclear, wind energy, a 160 times greater. The Federal subsidies for wind and solar have completely distorted

the wholesale market and they've made it uneconomic for thermal generators to survive and thrive in Texas. So what do we see now? This distortion is continuing in the Texas market where if you look at what's in the ERCOT queue today 35 gigawatts of new capacity is going to be installed in Texas, not a single wat of thermal generation. 25 gigawatts of solar and 11 gigawatts of wind, all driven by tax incentives, none of it driven by the need for resilience and reliability and that's a problem.

Leia Guccione (12:50):

Well, and I would say that actually, gets to a market flaw in Texas-

Robert Bryce (12:57):

Absolutely.

Leia Guccione (12:57):

... under valuing the value of resilience and reliability in the market product-

Robert Bryce (13:01):

And I will completely agree.

Leia Guccione (13:02):

... and that's where if we want to have these highly renewable low-carbon and reliable grid systems in the future, we not only need different and a diversity of technologies but we're going to need new market structures with new market rules that are ready to create the right financial incentives for these resources to be built in the places we need them to be built, operated in a way that supports both the financial interest behind them but the performance of the grid.

Scott Tinker (13:33):

Sure.

Robert Bryce (13:34):

Well, and I'll agree with most of what you said except for the renewable part. And what I don't understand is why there's this emphasis that it has to be renewable? What nuclear is being lost in this equation and if we're seeing more extreme weather and it appears that we are, why aren't we building more assets that are weather dependent, we need to be less vulnerable to extreme weather events. The solar and wind don't give us that attribute and that's my concern over the long term is that we're losing this focus on resilience and reliability. And this should be a top concern for policymakers all over this country and unfortunately it's not.

Scott Tinker (14:08):

You've mentioned diversity, you both have, that's both in the fuels and diversity in the kinds of equipment, resilient, affordable equipment. We're talking about solar and wind and we know there's clouds and there's night and things so there are times when they're not working and you need something else redundant. If it's a grid that has to meet a certain amount of demand and it's there then you have to have something else there when they're not there. So how do we deal with that? What are the options for redundancy? Or whatever word you want to use for that backup, how do we do that? What does that look like?

Robert Bryce (14:47):

Well, I'll just give one quick point right here which is that, as I said, renewables have a place but the fundamental problem when you try and build a renewable system that is all renewable or almost all renewable is the scale of the system. You have to overbuild it to such a massive scale you can't do it. So we talked about the idea of models and some models show this can be done. Well, you look at some of these models and like one that was put forward by Mark Jacobson that has been thoroughly debunked but it requires five and a half terawatts of installed capacity. The US today has about 1.1 terawatt, 1100 gigawatts of installed capacity.

Scott Tinker (15:26):

So five times?

Robert Bryce (15:28):

Five times the existing overall size of the grid in the United States today.

Scott Tinker (15:33):

So that one's debunked but are there other ones that are less than that?

Robert Bryce (15:35):

Well, or you look at the solar study that the Biden Administration put out a few months ago calling for, to get to 40% renewables or 40% solar, 1.6 terawatts just of solar. Well, I mean, this is a massive overbuild. Where are you going to put it? How are you going to connect it? How are you going to pay for it? All of these things are interconnected but this need for resilience and reliability but we have to be careful that we don't design a system that requires so much steel, so much copper, so much polysilicon, neodymium, lanthanum, all these other things that it overwhelms the ability of consumers to pay for it. So the reliability, its resilience, affordability, it all comes together around the scale of the grid and how it's designed.

Scott Tinker (16:15):

Is this conversation of redundancy and backup, is there in diversity, really? In addition to backing up with more wind and solar, what are the options? What do we bring to the table?

Leia Guccione (16:26):

Absolutely. First off, I would say our current system actually, already has a lot of redundancy and that's by design. So the North American Electric Reliability Council also known as NERC actually, has recommended standards for what's called resource adequacy or reserve margin. And so in most of the country, that reserve margin is expected to be maintained between 15 and 25% and that's so that we don't have blackouts so that we have modern, reliable, predictable electric service that our economy depends on.

Scott Tinker (16:59):

So more capacity than is needed?

Leia Guccione (17:01):

Yes.

Scott Tinker (17:02):

At anyone-

Leia Guccione (17:02):

And we'll continue to see a certain amount of redundancy as we build more wind, more solar and deploy other technologies onto the grid. And we should be careful about thinking about redundancy as a bad thing because I like to think that in some ways it's a feature, not a bug. The thing we want to avoid is economically inefficient levels of redundancy and so if we're able to use excess wind and solar that doesn't need to be delivered to the grid but instead to produce hydrogen, to charge a battery perhaps, that's co-located to the facility that redundancy's actually, a feature, it's an asset that we have.

Leia Guccione (17:41):

Other things though that we can use in the system to help us avoid redundancy are things like one, diversity. The shining of the sun has a very predictable pattern that has existed as long as the earth has existed. Now, whether or not the clouds will impede access to the sun, that's less predictable. Wind also has patterns but one of the things that we know is that by designing an interconnected system or having a diversity of resources so that maybe when the sun's not shining but the wind is blowing we still have power. So having diversity of resources is one way.

Scott Tinker (18:24):

... I want to make sure I, so if I have a hundred units working of solar in the day and it gets cloudy, does that mean I need a hundred units of wind available then? What's redundance, is it two X kind of thing? Or coming back to managing this grid with more solar and wind on it, am I back to natural gas load following plants or something that has to come on quick and go off? What do we do? I've talked to some solar and wind folks, they don't want any natural gas on the planet. Others are a lot more, "Yeah, we're going to need some load following plants for a long time to manage that." Where are we on that?

Leia Guccione (19:04):

I would say from the research that RMI, the organization I work for does, we don't need any new natural gas plants that being said, we don't want to get rid of the gas plants we have in many instances, we just want to run them a lot less and look at how we can run them or add either a carbon reducing or an emissions capturing technology.

Scott Tinker (19:34):

How do you see that?

Robert Bryce (19:35):

Well, here's my take on natural gas and I've said this for more than a decade. Where should we be going? Natural gas and nuclear, these are the lower or zero carbon sources that we can deploy at scale, the resources and the technologies are well developed and they have small footprints. So this idea that we don't need any more gas plants, well, that's not the case here in Texas where we're seeing a lot of population growth. You're seeing population growth in Colorado. You're going to need more thermal generation to assure a reliable grid.

Scott Tinker (20:05):

Right. So what are the challenges or the pros and cons really of utility scale batteries? Where are we on batteries?

Leia Guccione (20:16):

Yeah. So right now the bulk of the global battery market, it is batteries for vehicle applications. You still see a lot of innovation in personal electronics which is what actually, jump started the battery industry. But now the global auto making is what's driving the battery market and so batteries for distributed applications on the grid. So that power wall you might want to put in your home or that backup battery system for a building that and then also what you call utility scale. There's still less than a quarter of the total global battery market. So in some ways that is for utility scale battery applications, a challenge in and of itself because LG Chem and the other people who are making the batteries, their attention is on the auto sector.

Leia Guccione (21:10):

The other challenge for utility scale is that you still have a lot of diversity of chemistries, technologies and configurations that you're seeing. There's no clear winner in the utilities scale battery technology space right now. So that's both part of what's driving innovation but also that, because you still have that much diversity. If I'm an investor, I see risk in that. If I'm a grid operator, I see some uncertainty in that. And so that's part of what's still causing them to be more expensive but those are all things that we know will happen when a market is new and will through forces of competition and good regulation should work themselves out.

Scott Tinker (21:57):

Yeah, they could. I mean, we've had batteries for a long time.

Leia Guccione (22:02):

True. Yeah, absolutely.

Robert Bryce (22:03):

Can I jump in on the battery thing? Because since from the days of Volta to Edison to today, the batteries have gotten better but they'd still stink. I mean, you can't charge them too fast, you can't charge them too slow, you can't discharge... Like Goldilocks, everything has to be just right. It can't be too hot, it can't be too cold. And further what is clear is that the higher the energy density in the battery, the greater the volatility or the reactivity. And just in the last few months we saw a battery fired a utility scale battery facility in California, it caught fire. They asked the local fire department stay on site for six days in case the battery caught on fire again. So it's still a problematic technology for, at a utility scale.

Robert Bryce (22:44):

And we even see it in automobiles where if they're involved in an accident they catch fire and they can take 30 or 40,000 gallons of water to put them out. So batteries need to get better and I agree completely with Leia in that we need a new chemistry and solid state batteries may be the next big thing. But still to deploy them at scale, and we need them at the gigawatt and terawatt hour scale, it's an enormous challenge. And it's going to take, not just years, it's going to take decades to deploy them

at that kind of scale and further to me, the question is, is it going to be to back up renewables or the coal and nuclear plant's going to be charging those batteries during off times and then discharging during peak times? So the batteries can actually, reinforce some of the incumbent generation sources rather than renewables.

Scott Tinker (23:29):

Yeah. Interesting.

Robert Bryce (23:30):

Batteries are going to have a role but this idea that they're going to ride to the rescue, I think is fundamentally misguided.

Scott Tinker (23:35):

So in a timeframe if climate is a driver and we have a certain amount of time, we've got to do things faster than that.

Leia Guccione (23:42):

One of the things that I think helps that we haven't talked about is an over reliance on energy. I want to be careful about overusing the Texas example but there's a tremendous amount we can do with improving what we call the demand side of our energy needs. Less than a third of buildings in Texas are considered to be built to modern 1990s plus efficiency standards.

Scott Tinker (24:07):

Insulation, windows.

Leia Guccione (24:09):

Building envelope, the plug loads and appliances within the buildings and so-

Scott Tinker (24:15):

So we're just wasting energy-

Leia Guccione (24:16):

... exactly.

Scott Tinker (24:17):

... that you could save and do the same thing.

Leia Guccione (24:19):

Yeah. And so some building energy professionals in Texas looked at as an example, the difference between a 1960s house that had been retrofitted to best available efficiency technologies and then a very similar 1960s vintage home that hadn't. The home that had been retrofitted even though it lost power, it maintained an interior temperature in the mid fifties for the entire duration of the winter storm when they were without power whereas the building that hadn't been insulated and retrofitted, it was down to, in the thirties or the twenties within 12 hours of losing power. And so there's a lot of

opportunity for us to improve in our building stock and use the demand side of the electricity system as a resource in and of itself.

Scott Tinker (25:11):

Solar and wind are intermittent. They don't produce electricity when there's no sun or wind so they need redundant backup usually, from dispatchable sources like natural gas. But even those aren't always dependable in extreme weather. Robert says solar and wind destabilize the grid and make electricity more expensive. Leia says that to make a largely renewable system reliable, we need some combination of a smart interconnected grid, diverse resources and modernized operating practices. Those aren't easy or cheap and our initial experiences with them have been less than ideal. Battery solutions have been focused on the transportation sector. Grid scale batteries have challenges of competing chemistries and safety. Both guests agreed, we have not focused enough on resilience in the system. We'll hear more from them on part two of Could Solar and Wind Power Our Future?

Speaker 4 (26:36):

Funding for Energy Switch was provided in part by Microsoft and by the University of Texas at Austin.