CLIMATE SENSE

"The future is electric"

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Guests:

ROGER KRANENBURG
Vice President, Energy Strategy & Policy
Eversource Energy

LEAH STOKES
Assistant Professor, Department of Political Science
UC Santa Barbara

DAVID G. VICTOR
Professor, School of Global Policy and Strategy, UC San Diego
Nonresident Senior Fellow, Energy Security and Climate Initiative
The Brookings Institution

Host:

SAMANTHA GROSS
Director, Energy Security and Climate Initiative
Fellow, Foreign Policy, Energy Security and Climate Initiative
The Brookings Institution

Episode Summary:

This episode of "Climate Sense" is about electricity—the stuff that comes out of the outlet in your wall. Electricity is the future, but many of us don't think about it beyond the wall plug. In this episode, Samantha Gross explains that electricity is central to transforming our energy system. The costs of wind and solar electricity have plummeted in recent years, making them no longer cool and expensive, but now cool and cheap, in many cases cheaper than the fossil fuel electricity they replace. And electricity is a clean, quiet, and very efficient method for using energy in everything from homes to transportation to industry.

[electricity sounds; music]

GROSS: This episode is about electricity—the stuff that comes out of the outlet in your wall. Many of us don't think about electricity beyond the wall plug, but it is absolutely central to transforming our energy system to eliminate greenhouse gas emissions. In this episode, I'll examine why.

I'm Samantha Gross, director of the Energy Security and Climate Initiative at the Brookings Institution. I started my career in engineering and have been in Washington for 20 years now, working on energy and environmental policy—practical solutions to some of today's most important problems. Climate Sense is intended to help people understand climate change—both its causes and the solutions we're working toward. You can find all the episodes in the series at Brookings dot edu slash Climate Sense Podcast. In this episode I'll talk to three people with expertise in the electric power industry, about how to move toward a zero-carbon electricity system and what that system might look like.

Let's start with a basic description of what electricity *is*. Electricity is an energy carrier—a way of moving energy from place to place and putting it to use. Electricity is not a source of energy—it is *made* from energy sources like burning fossil fuel, the heat produced in nuclear reactions, using wind or water to turn a turbine, or directly from the energy in sunlight. Burning fossil fuels to produce electricity is the second-largest source of U.S. greenhouse gas emissions, just behind burning fuel for transportation.

When I speak or write about how our energy system needs to change, I often refer to a simplified formula: decarbonize electricity and electrify everything you can. Why is this such a good idea? Because electricity is the easiest part of our vast energy system to decarbonize: eliminating carbon dioxide emissions. The renewable energy sources that we hear so much about—wind and solar—produce electricity. Nuclear power, hydroelectric power, geothermal power, and other potential new sources of energy, like ocean waves—all these processes produce electricity without burning fossil fuels or emitting carbon dioxide.

To achieve our climate goals, the future is electric. But it's not just about climate.

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Electricity is a clean and quiet and very efficient way to use energy. For example, electric motors in cars or in industrial processes are far more efficient than internal combustion engines. Using electricity for as many uses as possible brings other advantages to people in addition to being a pathway to decarbonization.

Leah Stokes is a professor and an expert and advocate for moving towards a renewable electricity system. She advises NGOs and governments on how to change the electricity system for the better.

STOKES: I'm Leah Stokes, and I'm a professor at UC Santa Barbara, where I work on climate and clean energy policy. And I'm also an advisor at Rewiring America and Evergreen Action.

Electric utilities are my bread and butter, that's what I study.

GROSS: I asked Leah to fill us in on electrification and how clean electricity can do so much to prevent climate change.

STOKES: So, I've been working on climate change for almost 20 years now. And, you know, when you start working on climate change, you think, wow, this is an energy problem because a lot of our pollution, the vast majority, comes from our energy system. So, the solution to climate change I've understood in my work is really about clean electricity. Right now, about a quarter of our carbon pollution in the United States comes from our electricity system. So, if we can clean up that electricity system, if we can run it 100% or as close as 100% on carbon-free sources like wind and solar, hydropower, geothermal, even nuclear energy, which does not emit carbon pollution, if we can do that, suddenly we've got clean power. Great. Now, we've solved one quarter of the problem.

Well, actually, we've solved more than one quarter of the problem because then we can use that clean electricity to power our transportation sector. Our cars, even trucks. And that's another quarter of the climate problem right now in the United States. So, if we've got clean electricity and then we electrify as much of the transportation sector as problem as possible, we've solved about half of the climate problem.

Well, actually, we can get another half done, too, because it turns out right now we're using things like fossil fuels in our homes for cooking, for heating, and also in buildings, right? We burn fossil fuels on site. Well, what if we electrified buildings as well? What if we used a technology like heat pumps? Well, then we can use clean electricity to run buildings without polluting, without burning fossil fuels in those buildings.

And finally, there's even about half of heavy industry that can be electrified. We focus a lot on those really hard to decarbonize sectors, which is important. We need to figure out how to decarbonize cement and steel and other really energy intensive processes. But there's some of our heavy industry that can already be electrified with existing technology.

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So, when you add all that up, you get another quarter of the of the carbon pollution problem from buildings and about half of heavy industry. And that means clean electricity plus electrification can actually solve three quarters of our current climate problem.

GROSS: Wow! A clean electricity system can do a lot. But we have to remember that the future Leah describes isn't just a cleaner electricity system—it's also a much bigger electricity system, to provide energy to cars and buildings and industries that don't use as much electricity today. But we still have a ways to go to have a truly clean, zero-carbon electricity system. Right now the majority of the electricity in the United States is generated using fossil fuels.

STOKES: Well, we find ourselves in the year 2022, right, and right now, more than half of our electricity system, about 60%, comes from dirty energy sources like coal and gas. And we have technologies today that make up the other 40% of that mix: wind, solar, hydropower, even nuclear that does not create carbon pollution. We know those technologies work and we know that they can grow a lot bigger before we run into any technical problems.

GROSS: Coal and natural gas are the two most important fossil fuels used to generate electricity in the United States. Coal is much more polluting than natural gas, both for air pollution that harms human health and for carbon dioxide that warms the climate. Coal is about 22% and natural gas is about 38% of U.S. power generation—well over half of today's electricity is made from fossil fuels.

STOKES: The fact is, the electricity system does not have to run on fossil fuels. We know this not just because of researchers doing studies, but we also know because some electric utilities are already starting to do it. There is a big variation in how much pollution comes out of generating a unit of electricity. Some utilities in places like California, for example, where I live, are making a lot of electricity with less and less pollution each year. Other utilities that are currently very dirty, they are saying, you know what, we're going to stop being so dirty. We're going to get rid of our coal plants and we're going to turn to clean, renewable energy.

And then there is a whole other group of utilities saying, eh, you know what, we're going to keep our dirty coal plants open even though they're expensive. We're going to keep investing in gas plants.

But we can see that that's not required, that indeed, electric utilities could be really big champions of clean energy. They could make money off of it, and they could even expand how much energy they're selling, how much profits they're making by investing in more clean energy, and using that clean energy to power electric vehicles to heat and cool our home with electric technologies like heat pumps and induction stoves.

So, when it comes to electric utilities, I think they really can be the engines of clean energy and renewables in the future if they can only get their heads wrapped around it. And there's lots of variation in the industry in terms of how far along a given company is.

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GROSS: Leah is describing a very important change over the past few years: the costs of wind and solar electricity have fallen fast. Between 2010 and 2020, solar electricity costs fell by 85% and wind electricity costs fell by 56%. Renewable electricity is often cheaper to produce than electricity from fossil fuels. These technologies are no longer cool and expensive, they are now cool and cheap.

David Victor is a professor of innovation and public policy at the University of California in San Diego, a colleague of mine at Brookings, and an expert on climate issues. I asked him how a zero-carbon electricity system would look different from the one we have today. Will the system

just have wind and solar? What about the fact that they don't generate electricity all the time, but only when the sun shines or the wind blows?

VICTOR: Well, zero carbon electricity system might in principle look very similar to the electricity system today. In principle, you could imagine a zero-carbon electric power system that had a lot of nuclear in it, a lot of fossil possibly with carbon capture and storage. It might not be exactly zero emission, but near zero emissions. And those power plants could be turned on and off as needed, which is a little bit like the existing system.

What most people think is going to happen is that we make a big shift in the direction of renewables. And there's pretty good evidence that that not only is likely to happen for political reasons, but also the lowest cost way of doing zero is you continue to run nuclear plants on a system where you can extend the lifetime of those nuclear plants. Probably most, if not all, the coal in the United States disappears, natural gas remains. But the load factor might actually go down because you've got so much renewables on the power grid that, in effect, what the natural gas units are doing is they're coming on and off as needed to help integrate those renewables.

GROSS: David mentions nuclear power—certainly a controversial energy source. But nuclear is a key source of zero-carbon electricity, providing nearly 20% of U.S. electricity production, and nearly half of U.S. zero-carbon electricity. The argument today is less about building new nuclear and more about, as David says, keeping the nuclear plants we have operating until they can be replaced by other zero-carbon sources. Many of the nuclear plants operating today are approaching the end of their design lives, and the key question is whether those lifetimes can be extended safely.

David also mentions the load factor—the amount of time that a power plant actually runs and produces electricity. So, if a natural gas-fired power plant has a lower load factor, it is running less and producing less electricity, and less carbon dioxide. Power that is available exactly when you need it is really valuable on an electric power system, or grid, that has a lot of variable wind and solar generation.

VICTOR: There are some places in the country, a lot of work has been done in California in particular, that suggest that the load factor, that the amount of time the plant is operating, the load factor for gas plants might go down to something like 10%. So, you really have these plants just kind of hanging around waiting for those few hours to have their moment on the grid. And then mostly they just sit there idle waiting to do something.

And that's because as you go to zero and you do it with a lot of renewables, the renewables are variable in their output. The wind doesn't always blow and the sun doesn't always shine. And you put all of those variabilities on the system and what you end up with is a system that has much higher variability in generation. And because of that uncontrollable variability in generation, you need a lot of these other plants hanging around able to help integrate.

If you're willing to tolerate some emissions on that system, then those plants are probably going to be fired by natural gas. If you're not willing to tolerate any emissions on that system, then

those plants probably have to be hydrogen, or they might be something else, maybe some kind of a biofuel.

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GROSS: To get a utility professional's perspective on how these changes might actually happen, I talked to my friend Roger Kranenberg. I've known him for years, we worked together at a previous job, and now he's leading decarbonization strategy for a major regional utility.

KRANENBURG: I lead strategy and policy at Eversource. Eversource currently considers themselves a New England utility—gas and electric and water utility—and I am convincing them that they're becoming a regional energy company.

And in my engineering days, I worked on high voltage electricity equipment, on powered electronics, and things like that. My claim to fame is accidentally shutting down a power plant in southern Italy, a spectacular event.

GROSS: As Leah and David both described, for a progressive utility, there are real business opportunities in decarbonization and electrification. Along with other advantages for people and the economy.

KRANENBURG: Yeah, I think it's a better future in terms of the climate, in terms of conventional pollutants as well. I think you're going to get a product that delivers more consumer value, less impactful on the environment.

I mean companies such as Eversource, our electric business is the bigger part of our business. And all of these trends, social trends and climate change and technology and customer utility, they're all pushing value to our business, which is, which is a great place to be.

And then the other trend that we're seeing a lot, many regions are embracing this, like New England, and there's no exploration and production and refining in New England. So, as I put it to one senior government official, the car of your future will be fueled by offshore wind going through your network. Essentially, all the economic value stays at home, and this is a very New England thing, right? Because we don't have a big economy in, you know, petroleum exploration, production and refining.

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So, yeah, there's a lot of benefits to it. But I think ultimately what will really make it take off, this is just a better life.

GROSS: Okay, so we've established there are environmental and economic benefits to decarbonizing electricity. But will companies invest in the change? This is an important role for policy. The government can't and won't do all the work to move toward zero-carbon electricity, but it can set the objective and make it clear that the U.S. will move in that direction. Once

businesses understand the direction the government is telling them to go—the utilities are the experts in raising money and making things happen. They can do it.

KRANENBURG: So, private industry is very good, for example, ourselves, we can raise capital. If the policy's there, leveraging our ability to raise capital is a great lever for policy. You know, policy, this is probably not going to run the operations, get the investments, they can set up an environment where we go out to the street and say, we're doing this and it's supported by this policy, they're like, okay, how much do you need? So, you know being able to motivate private capital and bringing that together with government capital to overcome some of the, you know, sort of sticky points I think it is a great role for policy. And governments deploying this capital is probably not the right role, but sort of motivating private capital is, I think, is very good policy. Show me the money and I'll move that mountain for you.

And don't be overly prescriptive. You know, the I think of even with my kids, you tell them your end objective, don't tell them all the steps to how to get there because they'll come up with much better ways of getting there than you ever will.

GROSS: Roger focuses on investment and the role of policy in mobilizing investment. Transitioning to a zero-carbon power system will be expensive, but the government won't be paying for most of it. Zero-carbon power is a good investment and our private capital markets are happy to invest in the transition and enjoy the profits if government makes it clear which direction it is going.

But until recently, the United States has not been putting consistent policy in place to mobilize investment. Our government's climate message shifted dramatically from President Obama to Trump and now Biden. But finally, in August of 2022, Congress passed the Inflation Reduction Act, the biggest climate legislation ever in the U.S. The new law includes tax credits for investments in renewable electricity, electricity storage, and electric vehicles, among other things. The new law is designed to encourage investment in green technologies, and we'll talk about it in more detail in a later episode.

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It's also true that renewable technologies often cost less to operate, but all their cost is up front. Think of building a big solar array or a wind farm—you spend money to get the facility in place, but only maintenance costs going forward—there's no cost for fuel. This seems great; why is investment still hard? I come back to Leah for some answers.

STOKES: A lot of this is about the upfront costs of the switch versus the long term savings. So, for example, right now all across the country, there are coal plants that are operating and losing money compared to a new wind energy plant that could be built tomorrow. Why do those coal plants still stay open?

These companies have a financial interest in keeping these coal plants open. But that doesn't mean that it's cheaper to keep these coal plants open. It just means that certain people made bad investment decisions and they want to keep making those bad decisions because it's in their

financial interest. So, there are ways that we can write down that debt, shut down that coal plant, build the wind project, and actually start saving money when it comes to people's electricity bills tomorrow.

GROSS: If we're talking about writing down investments, that means there will be some financial losers. However, if the new overall system saves money over time, there is likely space to make those investors whole and enjoy the cost savings and climate benefits that renewable energy can bring.

STOKES: The same could be said, for example, with heat pumps, another technology that we have ready to go today, that when you first install that heat pump, it costs money upfront for people. Right? It's a little bit more expensive than putting in a gas furnace. But guess what? Once you have that heat pump installed, you save money every single month because it's an extremely efficient technology.

GROSS: Heat pumps are an example of electrification—switching from a furnace that uses natural gas, or oil, to an electric heating system. Such a system can be run on zero-carbon electricity and like most electric systems, it's a very efficient way to use energy.

STOKES: So, really, it's a financing issue where we can think about, you know, how can we get good investments at time one that save people money over the course of the operation. And that happens when it comes to wind and solar. And it also happens when it comes to things like insulating your homes, heat pumps, even electric vehicles. The issue is trying to get the money at time one and allowing those savings to accrue over time.

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GROSS: So, the investment issue isn't just about incentivizing utilities to install renewable electricity generation, it's also about encouraging individual homeowners to make changes in their systems that will cost money up front, but save money over time. Payback periods for investments vary a lot, but they can be quite short—around 2 years for a smart thermostat or 5 to 7 years for an electric heat pump. People who understand the benefit of the change and who can afford it will make these investments when they are upgrading their home systems—remodeling or installing new heating and air conditioning.

But we are in a hurry to reduce global carbon dioxide emissions to prevent further warming. Programs to finance changes for low-income homeowners and to encourage those with higher incomes to replace systems earlier than they otherwise might have is another good role for government policy and a way to move towards a more efficient economy.

Electricity is the future. The more the economy runs on electricity, the better off we will all be. The environmental benefits of renewable electricity are clear, but wind and solar generation have gotten so much cheaper that there are economic benefits also—for individual consumers and for the whole economy. As the economy runs more on locally-generated renewable electricity, we are less dependent on the geopolitics of global fuel markets, and also more secure.

Moving towards more renewables and more electrification is truly a no-brainer.

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GROSS: Many thanks to the experts I talked to in this episode. Fred Dews is the producer; Gastón Reboredo the audio engineer; and Matt Murphy the audio intern. My thanks also to Louison Sall and the communications teams in Brookings Foreign Policy and the Office of Communications. Show art was designed by Shavanthi Mendis.

You can find episodes of "Climate Sense" wherever you get your podcasts, and learn more about this show on our website at Brookings dot edu slash Climate Sense Podcast. You'll also find my work on climate change and research from the Brookings Initiative on Climate Research and Action on the Brookings website.

I'm Samantha Gross, and this is "Climate Sense."

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