CLIMATE SENSE

“Why do we use fossil fuels and why are they so hard to quit?”

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Episode Summary:

Fossil fuels built the modern world and brought us conveniences that we now take for granted, but science has made it clear that we need to move away from fossil fuels to prevent the worst effects of climate change. However, the energy system is the backbone of the global economy, and changing it quickly is a huge task. In this episode of Climate Sense, Samantha Gross speaks with Daniel Yergin about our energy system—how we got here and the challenges in moving to a new, greener energy system.

[music and speech montage]

GROSS: Science has made it clear that we need to transition away from fossil fuels—coal, oil, and natural gas—toward greener, lower carbon forms of energy to power our world. Climate change is the primary reason for this switch, but eliminating local pollution from fossil fuel production and use are also good reasons to move to greener sources of energy.

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 about 20 years now, working on energy and environmental policy—focused on practical solutions to some of today's most important problems. This episode of Climate Sense is focused on our fossil fuel energy system—how we got here and the challenges in moving on to a new, cleaner energy system to prevent the worst effects of climate change. You can find all the episodes in this series at Brookings dot edu slash Climate Sense Podcast.

The climate system is cumulative—adding more carbon dioxide to the atmosphere will cause more serious consequences as time goes on, like floods, droughts, more severe weather, increased human migration, loss of species, you name it. Therefore, scientists tell us that we need to achieve net-zero emissions of greenhouse gases by the middle of this century—a really difficult task that we'll talk about throughout this episode.

Russia's war on Ukraine has also highlighted the geopolitical challenges of continuing to rely on fossil fuels. We produce a lot of oil and natural gas here in the United States, but an important share of the world's supply comes from countries that we may not want to do business with, Russia included, but also countries with non-democratic governments or countries with low environmental standards.

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Ending the world's reliance on fossil fuels also ends the flow of money toward regimes that rely on fossil fuels for revenue, including Russia. But when we think about how to move away from fossil fuels, it's really helpful to understand how we got here in the first place and the challenge of changing such a vast system of energy production and use.

My guest on this episode is a colleague and friend who literally wrote the book, in fact, several books, on such things.

YERGIN: I'm Daniel Yergin and I've written a series of books that really narrate and describe the energy journey that we've been on for the last three decades. *The Prize* was really about oil, money, and power. *The Quest* was the bridge between oil-renewables, how climate went from being an issue that was only of concern to a few scientists in the 19th century who worried about another Ice Age to this pervasive global issue today. And now *The New Map*, my new book, which is about energy, climate, and the clash of nations that we see unfolding on the world stage today.

GROSS: Fossil fuel use came about, well, because fossil fuels are really useful. Before fossil fuel use started in the mid-19th century, people relied on plants for fuel, and on human and animal work ultimately fueled by plants. The pre-fossil world was entirely powered by solar energy, through plant photosynthesis and the movement of wind and water.

Fossil fuels allowed people to do much more than we could by burning or eating plants. First coal, then oil and natural gas, provided concentrated energy that we could store, transport, and easily use. They also helped to alleviate some of the most important environmental problems of the turn of the 20th century: destroyed forests and an endless supply of horse manure.

YERGIN: Fossil fuels have been very constructive. Hydrocarbons were what took us out of the dark ages into the modern global economy. It's the basis of this now about a 90-trillion dollar world economy and everything we've seen in the doubling of life expectancy, standards of living, the way we live it's all been made possible by this hydrocarbon foundation, which is about 80 percent of world's total energy today.

GROSS: Now, well into the 21st century, we understand that fossil fuels are a key cause of one of today's most important environmental challenges—climate change. But fossil fuels' concentrated energy powers the modern world and makes possible so many things that we view as necessities today: water movement and treatment, food production, manufacturing, transportation, refrigeration and air conditioning, communication and computing. Using fossil fuels to generate electricity, a super-flexible way to transport and use energy, make many of these activities possible. And the energy system that supports all these activities is huge.

YERGIN: There's an enormous amount of engineering that supports the energy economy that we have today. To create a whole new global energy economy in less than 30 years will involve an enormous amount of new engineering to achieve that. And now we're down to 2050 is 28 years away. And, it's really ambitious when you think about it.

I think with energy, you have to keep in mind scale. Imagine this is a 90-trillion dollar world economy. And what's required to make it run? A hundred million barrels a day of oil. And that's only about a third of the total energy that the world runs on. And there's so much manufacturing that goes into it, so much scale that goes into it. There are close to three hundred thousand miles of pipelines that carry oil in the United States from one point to another. The Keystone XL pipeline got huge attention, but that would have added, what, maybe 1 percent to the amount of pipelines in the United States.

GROSS: One piece of good news is the tremendous progress the world has made in renewable electricity generation. These technologies are no longer a niche thing—wind and solar dominated new electricity generating capacity built in the U.S. in 2021, with a combined share of more than 75 percent. But still, wind and solar were only about 13 percent of total electricity generation in the U.S. that year.

YERGIN: Modern wind and solar are 50-year old businesses. But it was only within the last decade that they really achieved scale, and cost came down so dramatically for solar, 90 percent for a solar panel. Not as much to install it because you still need somebody to go up in the roof and do it. So, those costs have come down, but not to the same degree. And a lot of solar progress has been the result of Chinese manufacturing on a vast scale. The Chinese now provide 80 percent of the solar panels. Wind turbines are so much bigger and so much more efficient, so that's where a lot of progress has been made.

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GROSS: We constantly hear about the urgency of changing our energy system—climate science tells us that we are in a hurry to avoid the worst effects of a warming world. But to deal with the challenge, we have to face it head-on and acknowledge the scale of the current energy system and the level of effort needed to change it. It's not just installing more wind and solar generation to remove emissions from the electricity sector; we also need to remove emissions from the one hundred million barrels of oil per day that run the world's economy, like Dan mentioned. Electricity can replace some of that oil as we transition to electric vehicles, but not all of it. We're still developing new technology for some of those other uses.

The energy transition away from fossil fuels will be a challenge unlike anything humankind has done before. The energy system has transformed before, especially when coal use eclipsed traditional biomass as the world's largest energy source in the early 20th century. Since that time, coal has given way to oil as the world's largest energy source.

But two *big* things are different now. First, like I said before, we're in a hurry. Previous energy transitions happened because new sources of energy were easier to use or allowed entirely new technologies, like the internal combustion engine that runs cars and trucks today. And these energy transitions took many decades. This time, we're changing because we must to avoid environmental outcomes we don't want to live with.

The second big difference is that previous energy transitions have been additive. We've not abandoned old sources of energy, just added new ones. Here are Dan's thoughts on that topic.

YERGIN: The energy transitions that we have seen have unfolded over a century. And it's not really energy transition, it's energy additions. Because oil after a century overtook coal in the 1960s as the world's number one energy resource. And today we use three times as much coal today as we did in the 1960s. Now you're talking about simply completely transforming the energy system in 28 years, as though we have the engineering capacity to do that.

GROSS: Our use of energy grew so fast over the last century that we just added new sources on top of the old ones, which also continued to grow. As Dan said earlier, fossil fuels are still 80 percent of global energy use. Oil alone is nearly a third of global energy consumption. This time, if we want to have any hope of lowering greenhouse gas emissions, we need to nearly eliminate some forms of energy, or at least eliminate their use without emissions abatement. We've truly never done anything like this before.

And there's an added level of difficulty—we have to run the economy on the energy system we have while also making the transition to new sources of energy. We have to keep running our factories, lighting and cooling our homes, moving people and goods, building new things. It would be great if we could snap our fingers and create a new energy system that meets our needs, but that's not possible. It's not just an engineering challenge, but also a question of how to direct investment during this unusual time in history.

YERGIN: There is going on now a capital transition, money moving from traditional investment in conventional energy into looking for renewables for green projects. A lot of government pressure and regulation to do that. But the reality is that the world still uses 80 percent of its energy from hydrocarbons. And, for instance, oil resources, oil production you deplete about 5 percent a year. So, just to maintain production, you need new investment. And in order to meet what will probably be growing demand for the rest of the decade you need additional investment. And right now, it appears that there's underinvestment going on.

GROSS: Concerns about underinvestment in oil and natural gas have really come forward since Russia's invasion of Ukraine. Less Russian energy is on the market and prices have gone up accordingly. People in wealthy and developing countries alike are all complaining about high energy prices and wondering when more supply will be available.

YERGIN: And if you have that, then you're going to have a series of shocks and you'll have a backlash. And that will be a big problem, particularly for developing countries who are at a very different stage who face not only what's called the existential questions around climate, they also face the existential questions around economic growth, reducing poverty, improving health, and who see conventional energy as part of what they need and point out that they're the source of very little of the CO_2 that sits in the atmosphere today.

GROSS: The energy transition poses special challenges for the developing world and for regions or countries that rely on fossil fuels for revenue and jobs. I'll devote a whole episode to these issues later in the series.

Dan suggests that the energy transition won't be smooth sailing for producers and markets. It makes sense—the industry is just guessing about how fast the transition will go and how much they should invest in today's fuels versus the energy sources of tomorrow. For those who say we shouldn't invest anything in fossil fuels now, I remind you that we have to feed the system we have today while we are moving toward the new system. This will be a difficult tightrope to walk, but it's where we are.

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We think of the energy transition as being away from fossil fuels, but it's also a transition toward new resources, especially certain minerals. Batteries that power electric vehicles or back up the electric grid require lithium, cobalt, and nickel; solar panels need cadmium and gallium; wind turbines need rare earth minerals for the magnets within. Unlike fossil fuels, these materials are used to build new equipment; they aren't needed as a fuel for the existing equipment to operate. So, the world will need less of them and shortages will be less acute. But still, we're not moving away from drilling and mining—just drilling and mining for different materials.

YERGIN: So, even wind and solar on the scale that people are thinking about would involve so much more manufacturing. And what people don't realize is the IEA, International Energy Agency, put it, you go from a kind of fuel based economy to a mineral based economy. And in *The New Map*, I came up with a phrase "we'll go from Big Oil to Big Shovels" because it would be so much mining. You're talking vast increases in these resources. Right now, we're just doing a study of what's involved in copper to achieve the net zero carbon targets are there. Enormous new supplies will be needed. And by the way, it takes about 16 years on average to open a new mine.

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GROSS: Yes, copper. It sounds less exciting than rare earth minerals, but we're moving toward an energy system that relies more and more on electricity, and copper forms the backbone of electrical systems. The world is bound to need a lot more copper, with the energy consumption and environmental challenges that come with all extractive industries.

We've established that getting away from fossil fuels will require a lot of effort and that we'll still be in the extraction business. But what does getting to net zero emissions really mean?

YERGIN: I think of net zero as a direction. The world is moving towards decarbonization, whether it happens in 2040 or 2050 or 2060 or 2070. That's the direction the world is going, and it's going to involve a lot of technology that doesn't exist today. And I think the Paris Climate Conference in 2015 defined the what, which is two degrees, then one and a half degrees, and that became transmogrified into this notion of net zero carbon by 2050. So that's the what.

The how is not at all clear at this point. So, all over the world, countries, companies are adopting net zero carbon targets. For some companies, it's very doable. But for a lot of people, it's not at all clear how you achieve it and what technologies you're going to need to get there.

GROSS: Some greenhouse gas emissions are just hard to get rid of. Wind and solar technology are great, but they make electricity intermittently, when the wind blows or the sun shines. Finding ways to store electricity from these sources is a crucial challenge.

Decarbonization will involve running everything we can on zero-carbon electricity. But not everything can be electrified. For example, batteries are large and heavy, making electric aviation and electric maritime shipping difficult. Also, when you need very high heat for an industrial process, electric heating generally can't get hot enough and so you need to burn a fuel. Some industrial processes, like steel and cement, emit carbon dioxide, the most important greenhouse gas, as part of their chemistry, not just from fuel use.

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In particular, transformation will be harder in some parts of the economy than others. Here are Dan's thoughts on some of the most important areas for new technology development.

YERGIN: Technologies take a long time. I said wind and solar: it took 40 years before they became commercial. Shale, oil, and gas took about 25 years before it became commercial. The Moderna and Pfizer vaccines: they weren't invented in a year, they were 30 years of technical development. So, there's probably a lot going on in labs, researchers, people with ideas that are not in the mainstream right now, which will have an impact, but they won't have an impact tomorrow, but they'll have an impact in 20 years.

As you once said to me a few years ago, Samantha, storage—battery storage of electricity. I remember our talking about it and your saying that that's where if you have a really big breakthrough—because obviously there's a lot of advanced batteries, but they get to scale in batteries to store electricity—that would be a game changer. The other area is what are called the hard-to-decarbonize sectors, which are things like steel, heavy industry, where they need heat and so forth. And that's where people are thinking, is hydrogen going to be the substitute for natural gas?

GROSS: These issues are why there is a "net" in net zero. For many uses, fossil fuel energy can be replaced, although with all the challenges we talked about earlier. For those harder areas, we have *net* zero—rather than eliminating the most difficult sources of emissions, we remove an equal amount of greenhouse gas from the atmosphere another way. Projects involving forests, agricultural practices, or even direct removal of carbon dioxide from the air can make up for those emissions that we just can't quit. This isn't a cheating strategy or a way to avoid the real issue of fossil fuel use.

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These practices will be needed in addition to eliminating fossil fuels everywhere we can to get all the way to zero and stabilize the climate. This is both/and, not either/or.

Dan brings up the subject of hydrogen, a technology we often hear about as a way to get to net zero emissions. Hydrogen is useful stuff, but it is often misunderstood. You don't drill for hydrogen; you make it from another form of energy. It's an energy carrier like electricity, not an energy source like fossil fuels. Today hydrogen is mostly made from natural gas, splitting molecules to strip out the hydrogen. The future promise is in making hydrogen using renewable electricity to split water molecules, completely without carbon dioxide emissions.

The advantage here is using renewable electricity to make something that acts like a fuel—you can burn hydrogen, store it, and transport it in ways similar to how natural gas is used and stored today. A large-scale hydrogen industry could make getting to net zero a lot easier. But we still have a long way to go.

YERGIN: Well hydrogen is the lightest element in the universe. And the notion is that the lightest element in the universe will become a really heavy duty energy supplier, but it isn't a resource that you can go and mine or drill for. You have to make it. And it's made now largely from natural gas, also from coal, because you have to split molecules to get to it.

In the last year and a half or so, there's become a lot of excitement about hydrogen, and hydrogen is a commercial engineering business today used either in oil refineries or to make fertilizer. But there is no hydrogen energy business today. And like the EU, some of their targets have 25 percent of their energy coming from hydrogen by 2050, except there is no hydrogen business today.

Hydrogen is not a case where you just put up something and the sun shines and you have it. It's a really big engineering project to do it. And to get to scale is a really big deal. And so we're still at the stage where people are trying to figure it out. And so, you're going to have pilot projects. But right now, I think that while there's great potential, the number of words and the expectations are far outrunning what's up and running and will be up and running in the next few years.

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GROSS: I've been talking this whole episode about the role of fossil fuels in climate change and the challenges of transforming our energy system. But fossil fuels are ubiquitous in our world today, not just as energy sources.

YERGIN: Even in the net zero carbon scenario of the International Energy Agency by 2050, oil and gas are still significant energy resources. By that time, the energy pie is much bigger and their share of it is less. And you're going to need carbon capture is an important part of the going forward strategies.

But what people don't realize is how much else oil and gas go into. If you're wearing a North Face jacket when you're outdoors because it's cold, it's a polyester polyurethane nylon product. It's virtually all an oil product. If you fly in a 787 jet, the body of that plane is a carbon product. You look at medications. If you've ever taken Tylenol in your life, it's an oil product. So, you just go down this list and it's so much more pervasive than you realize. It's in so many more materials.

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So, it isn't just what you put into your gas or petrol tank. It's all these other things. It's kind of, in many ways, a building block of the world in which we live.

GROSS: Oil and natural gas are not just fuels, but sources of the carbon in many products we use every day. Plastics are everywhere and they start their lives as oil or natural gas. Fertilizer depends on natural gas. Oil and natural gas are everywhere.

The world certainly will be changing, and must change, its relationship with fossil fuels, but it will not be saying goodbye completely. As I said at the beginning, fossil fuels are useful in so many ways. The key is to use them sparingly, only when we really need them and in uses where we can capture or offset any associated carbon dioxide emissions. This is *such* a change. For a century we thought of the atmosphere as an inexhaustible sink for such emissions and didn't even consider carbon dioxide as a pollutant. We exhale carbon dioxide when we breathe—how bad can it be? How the world has changed. And now we’re trying to retain the economic and quality of life advances that fossil fuels brought us without suffering the consequences of climate change. We’ll need a lot of skill among engineers, politicians, and everyone in between.

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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.”