

ECN 002 BEYOND ZERO NEUTRAL WITH DR. SAM GOODMAN

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SPEAKERS

DAVID VAGNETTI, INTRO, Sam



INTRO 00:00

Welcome to Environmentally Concern Nation, the environmental show that goes way beyond water cooler climate debate. This podcast features the science, policy, politics, law, engineering, and public opinion that matters to you. Why? Because you are in control of the environment and no one else. Yes, you decide to go green or vegan. Our collective choices will determine the fate of our children. Welcome our host DJ Vagnetti. DJ is an environmental civil and water resources engineer. But this show is not about him, but about the fate of young and future generations to come.



DAVID VAGNETTI 00:40

Welcome to Episode Two of Environmentally Concerned Nation. In this episode, Dr. Samuel Goodman and I will discuss the three movements or initiatives the most coexist if you're about to defeat mankind's greatest foe, climate change. So if you want to know what needs to happen to put an end to the environmental crisis, learn more about the sacrifices that we must make before it is too late. And get first hand information on the real threat from a reliable source. Don't you move from where you are Dr. Samuel Goodman is an expert in climate, an author, of best selling book Beyond Carbon Neutral. His accomplishments are, he's an Eagle Scout. He's a chemical engineer, a doctorate in

philosophy in chemical engineering, and the best selling author of Beyond Carbon Neutral. Welcome, Dr. Goodman. Thanks for having me on. Can you tell the audience a little bit about your background, please? Sure. So I'm a chemical engineer by training, I did my undergraduate and graduate work in that field. While working on my PhD, I worked on a couple of energy related topics, I looked at some new types of solar cell technologies that, uh, well didn't necessarily pan out. But that's research for you look a little bit at thermoelectric devices as well. And then after that, I transitioned a bit and I worked more in the public policy space, which has been my focus for about the past five years now. Great. When did you first got interested in writing and research in climate change in terms of, you know, being interested in climate change that goes way back in my background, there's a document somewhere in my parents basement, that's a speech I gave, and I think it was 10th grade about the importance of climate change. And in the two decades, since then, of course, it's only been more important and more present than ever. So it's something I've always been interested in, because it is such a dramatic challenge. And really, I've had these ideas floating around in my head, but it took the pandemic a little bit where we were all stuck in quarantine, and then have a whole lot to do otherwise, for me to really have the time to put pen to paper and write this book and get it out there. Great. Your book is doing really good as you just as you mentioned me and to me, you're right. Yes, it's the number one new release in the renewables category on Amazon. That's so great. Awesome. So why is climate change the greatest foe of mankind have ever faced? Well, I think it is the greatest challenge we've ever faced, because it does have the potential to really end our civilization as we know it, if not our entire species, if we don't take dramatic action to really reverse the damage and try to recover from this because it shifts every part of our society as function and how is ordered itself on But till now, it will change how when where agriculture is viable. So that determines, you know, how much food is available, it'll change water resources, and all that will shift where people can live. And essentially the kind of society that we can then build, because those kinds of dramatic changes will create massive amounts of upheaval, people migrating substantially across the entire world. And it'll be a real challenge to try to survive all that in the long term. So whether you think I mean, we we're gonna start seeing the effects. I mean, like, catastrophic effects of climate change, I mean, not to the environment, because that's already happening. But I'm talking about human beings. I mean, we've started losing lives because of climate change.

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Sam 04:18

Well, I think we're already starting to see some of that already looking at some major events of the past 10 to 15 years, the civil war in Syria that has roots going back to climate change, because there was a prolonged drought in that country, which forced an internal migration which led to increase political tensions that then exploded into the conflict

that's still ongoing right now with all its different facets that came out about with it. We're also seeing a similar conflicts in Africa, the Darfur conflict was as significant routes also going back to water availability. So we're already seeing these kinds of tensions and conflicts going on across the world, and that's only going to, you know, become more common and more prevalent as time goes on.



DAVID VAGNETTI 05:05

Yeah, water conflicts. So about a big topic, and I'm gonna have a show about that. Because water a conflicts go way beyond climate change, for example, if you construct a dam in denial or something like that you're gonna have, like 20 countries indam has, its a structure, the unique structure that has the most environmental impacts. I mean, there's no other structures that can match that environmentally.



Sam 05:30

Dams are huge things, I mean, the one that they put up in China that literally slowed the Earth's rotation a little bit by the amount of water it held back and how much change that caused. That's crazy. So where are the significant challenges concerning climate change and how we will overcome them. So I think the biggest challenge with climate change is just the inertia that's going behind our current mode of operations. So for the past 150 years, we've built our entire society around the extraction and use of fossil fuels. So everything from transportation, heating, electricity, all of that is based around, you know, this pretty much free energy source that we just have to dig out of the ground. So when confronting climate change involves addressing and changing that fundamental baseline for how we operate, that takes a lot of force to overcome that inertia. So I think really overcoming that initial barrier to making those substantial changes is really the greatest challenge before us.



DAVID VAGNETTI 06:36

Yes, it's nice was you mentioned in a , I believe that when we started to use oil, I mean, we started to dig up. I mean, nature selected for extinction and using it right back on, you know, and I think I mean, that we started to play with fire,



Sam 06:56

literally, my opinion, way to put it, you know, so,



DAVID VAGNETTI 07:01

and your book, you talk a lot about sacrifices, what I didn't necessarily sacrifice is every environmentally concerned citizen must endure if we are to be victorious, against climate change.



Sam 07:12

So what I highlight in the book is, you know, some of those pressure points where things are going to change, or likely have to change to make a lot of progress on this. So I think one of the good examples that I like to draw on a lot is the idea of air travel. So in Europe, there's this whole movement, where people are voluntarily stopping, you know, taking flights, because there really is no way to decarbonize that right now. Now, there, you know, synthetic and other kinds of biological fuels, you could use to power aircraft, but you can't really plug in a plane to batteries, they just don't have the energy density. So you're going to be relying on some form of combustion, and that's naturally going to release you know, carbon dioxide into the atmosphere. So if you really want to be, you know, minimize your carbon footprint, you have to give up flying. The problem is, and this is something that affects me directly. If I give up flying, I basically don't see my family over the holidays. You know, on either side, my wife's family lives 1000 miles away, my family lives 1000 miles away, and there's really no other good way of getting there efficiently except my face. Yeah. So it's, it'd be a sacrifice to do that. So just kind of what I lay out in the book is exploring those things. And, you know, looking at the problem, but not only discussing, you know, what has to change, but also ways that we can potentially make that easier. So if instead of flying, which you can't really decarbonize, what if we invested more in like high speed rail infrastructure, which can basically do the same thing, but that can run wholly on renewable electricity? So just trying to see what needs to change? What are the barriers to that change? And then what are ways we can overcome that, and the easiest way possible, that disrupts our lives the least so the sacrifices don't have to be as big as they might otherwise be? Sure.



DAVID VAGNETTI 09:10

Rail For example, I mean, you might fly over my house, but you're gonna drive a railroad. I mean, through my backyard, you see what I'm saying?



Sam 09:20

Exactly. It brings up other questions. Yeah, ranging from eminent domain to all these other kinds of things that we'll have to deal with. So once you start to dig into these, all these

problems are interrelated and it just becomes complicated. So that's why it's important to just address it head on. Why don't we just go beyond carbon neutral? And why is carbon neutral? Just not good enough? Yeah, that's a good question. Because, you know, you see in the news and reports people talking about will reach net neutrality by 2030 2050 by some date in the future. And basically, that means that we're at the point where we're putting no more carbon dioxideThe atmosphere then is naturally coming out of it. And the problem with that, though, is that we've already increased the natural amount of carbon dioxide in the atmosphere to such an extent that even if we reach net neutrality, we're still going to see persistent problems in the future. So what's really critical is to really roll back further take more carbon out than we put in. So we start drawing this down, essentially helping the climate recover from what we've done to it thus far. And that way, we can start to reverse some of these changing weather patterns, ocean acidification, things like this, that are really help return us to a much more stable level, rather than just trying to maintain or not make things worse. So you implying to use some of the geoengineering proposals have been lingering in around the place he and his own fan, that depends on the specific proposal. And the second part of the book dives into all these different things that we could do to bring carbon out of the atmosphere. That's awesome. What are the three global movement that must coexist as far as beyond carbon neutral is concerned. So pulling carbon out of the atmosphere is one of them. That's the second that I talked about. The first one is really replacing our energy grid, moving away from fossil fuels and replacing it with wholly renewable sources of power. Let's see how those two pretty much technical goals that we have to achieve. So then the third movement is rallying the necessary societal institutions to really make those things happen. So you have to have those three things happening in concert, to really reverse climate change, we have to stop making it worse, by replacing a power grid, we have to reverse the damage by pulling carbon out. And we have to enable those by rallying as a society to make that happen. I'll see. But in the book, it says little fun saying something interest that it seems so odd for scientists to seemingly advocate against doing more research. Why is that? Yeah, so that's an interesting conundrum. Because as I mentioned, before, I did my PhD work in chemical engineering. So I was very enmeshed in this this research ecosystem. So it's a bit weird to be advocating against, you know, doing more research, but it's a bit more nuanced than a top line description of that. Because, you know, of course, doing more research is great, it'll improve technologies that will make things easier going forward, the issue is, we don't know when those breakthroughs will happen. And we don't know what kind of effect those breakthroughs will happen, will have, because otherwise, they wouldn't be research, it just be an engineering problem. And if we don't know what's going to happen, when it's going to happen, and what effect it's going to happen, then, you know, if we're spending time waiting for some new technology to arrive, you know, we could have, if it doesn't pan out, we'll just wasted that time when we could have been taking concrete steps with the technologies that we currently have available. So what I lay out in the book is that we're

at a point now where we have the base technologies right now where we can actually solve the problem in its totality, we might not have been able to do that 10 or 15 years ago, but really additional research by now won't change the fundamental calculus that we can affect the change we need right now. And any time we resources we spend on you know, spinning our wheels waiting for more research to happen. It's just so much time that we won't dedicate to really reversing these effects. While we still have time true, I believe the windows will litter about the national environment. I mean, doing more research, actually, we don't know much about what is going to happen. That's the biggest concern and climate change, you know, is in uncertainty. It's not like other for example, disciplines that you have out there. I mean, the environment and we know very little about, I mean, we know a lot about water footprint, but about the carbon cycle, the carbon footprint, what is gonna happen, I mean, it's like, when you see a, for example, a hurricane, just the slightest change in barometric pressure will determine if your house is gonna flood if it's not, if it's gonna blow away, you know, someone who's saying, Yeah, and like climate, you know, as a whole is such a complex and dynamic system, you know, there is always uncertainty and all these models and the further forward in time you get, you know, the wider the error bars get. But, you know, the fundamental thing is, it's not going to get better if we do nothing. I mean, instead of doing research, just put it to work.



DAVID VAGNETTI 14:28

Exactly. So let's talk a little bit about nuclear power. First of all, do you think nuclear power should be part of the holistic approach to alternative energy, and nuclear power is a very divisive point of contention in the environmental community. So what is your take on that?



Sam 14:50

So in general, my answer to nuclear is yes, with a very big asterisk attached to it because you know, I get it. Nuclear can have some major downsides to it. You know, we've seen the HBO series Chernobyl, very good dramatic series. But the problem is when you take nuclear offline too soon, like they did in Japan and Germany, they just replaced those with more fossil fuels. And, you know, nuclear by itself, it doesn't emit carbon. So when you retire that too early, any new renewables you're bringing online are going to be cutting into that first before it can really dig down deeply decarbonize your coal, your natural gas, so taking it off too soon, is not going to work in our benefit. The problem is nuclear. While it doesn't release carbon, it has a similar downfall as fossil fuels, in that there are only so much uranium in the ground that we can feasibly mine. So just as we'd eventually burn up all our natural gas, we would eventually burn through our reserves of nuclear fuel. Now, that might be 100 200 years in the future, eventually, we would have to make another transition to replace those anyway. So in my mind, if we're being efficient about this, why

not just you know, go holy, renewable from the outset, to build a power grid that'll be sustainable indefinitely,



DAVID VAGNETTI 16:13

you'd believe that we would run out of uranium in 100 years, 200 years,



Sam 16:18

it depends on you know, where you are in the world, and the proven reserves that are, you know, easily available to you, it's still a relatively rare material, it is fundamentally depletable. So what we can do those as we do need to keep our reactors running as long as possible to make our transition easier, we can do things like nuclear fuel reprocessing, like they do in France, which makes a much more efficient cycle and reduces the amount of nuclear waste that has to go into long term permanent storage. There's also a potential use here, if the technologies arrive. So as I mentioned before, we're not relying on any unproven technologies. But if they do arrive different forms of nuclear energy that can take you know, spent fuel, use it more efficiently and basically continue the lifespan of the material we have available already, we could burn that up in these new types of reactors that they're developing. And since those, you know, they provide a lot of power all the time, we could dedicate that to pulling carbon out of the atmosphere, 24 hours a day, seven days a week until it's done. And then we use up those resources efficiently and then move on from there, we can retire it fully. So the basic idea around nuclear is we have to keep using in the short term, there are some uses for going forward. But fundamentally, if we're looking out in the far long term, only renewable technologies will be viable.



DAVID VAGNETTI 17:46

I see. The United States is one of the largest emitters of carbon, but still accounted for 59% carbon dioxide emissions is re entering the party's agreement, the path forward for getting other countries are working together to make progress.



Sam 18:02

So the Paris Agreement is an interesting thing, because it represents fundamentally, you know, this desire on the part of a lot of countries to make substantial progress on this issue. And recognizing that climate change is a fundamental problem that needs to be addressed. The issue is that it's largely voluntary, so you can't really force another sovereign country to really decarbonize their power grid through this kind of agreement

going forward, even in countries right now that it's anticipate that they're going to miss their targets, but there's really no consequences for doing so. So, as you mentioned, the US is, you know, a large emitter, but still not the majority source across the world. But historically, you know, the United States Europe have been responsible for, you know, cumulatively, the majority of emissions over time going back to like the 1850s, up to now. So I think, if you're looking for a way forward to help other countries transition, because, of course, you also don't want to kick away the development ladder, you know, we got to our level of our standard of living through fossil fuels. So naturally, other countries want to follow that as well as they improve their own standard of living, we have to provide a better alternative for them to develop their infrastructure. So I think, you know, the United States, the West in general has a responsibility to help that going forward by making access to these technologies and infrastructure easier for other countries so they can do that other 85% of the problem that needs to be addressed.



DAVID VAGNETTI 19:40

So how are you proposing this holistic approach? You know, we may, all this different energy sources work together, like solar and wind and hydroelectric, that are intermittent, it's just a matter of adding a bunch of batteries. So



Sam 19:56

yeah, that is the crux of the problem with dealing with renewables because you Not only on a day to day basis are you going to get fluctuations in your sun, your wind, your hydro power, but that also is drastic across seasons, because of course, in the winter months, we get much less sunlight than we do in the summer is just one example. So we have to do is the two DS diversity. So wherever we are, we need, you know, multiple different sources of power so that if one is diminished, another one can take over. But we also need depth. And what I mean by that is, you know, you're playing about batteries, we do need energy storage. And that's a critical piece for being able to fully retire all these fossil fuel peaker plants that kick on when you know, renewables aren't available. So I dedicate, you know, to pretty beefy chapters to addressing the problem, you have the short term storage needs, where you have things like batteries, thermal storage, pumped hydro power, and compressed air to help mitigate the day to day fluctuations. And then over seasons, I'm looking at how we can generate renewable fuels to essentially be a an artificial harvest that we do in the summer when there's plentiful sun and other renewables, and then using those in the winter when we need to recover that energy to make up deficits.



DAVID VAGNETTI 21:14

So if I'm not mistaken, what you mean by depth is like, actually all forms of potential energy,



Sam 21:21

right. So you have your short term energy storage, like, let's say you have a thermal battery that can kick on almost instantly, you have potentially some kind of pumped hydro power that can spin up in a couple minutes. And then you have these fuels that can kick on, you know, months later, after you generate the fuel.



DAVID VAGNETTI 21:41

That's awesome. Stopping putting copper dioxide in the atmosphere is one thing, how do we take it out so that it isn't going to deplete all of our resources?



Sam 21:50

So I think the critical thing, your question there is the the depleting all of our resources part, because when you think of carbon capture, you think of these massive industrial pieces of equipment that take carbon dioxide out of the atmosphere and artificially capture it, you like fake trees or something like that? Yeah. The problem with that is though, like, even though we have been pumping carbon dioxide into the atmosphere, is still like the equivalent of like half a sugar cube dissolved in a gallon of water. That's the kind of concentration we're talking about. So it takes a ton of energy and resources to pull a substantial amount out of the air. If we're doing that artificially, which only adds to the amount of energy infrastructure, we then have to build out to really complete our project. And that's going to take a lot of time and resources to do. So the conclusion I come to in the book is that our most efficient method of doing it is to, you know, let nature give us a helping hand, rebuild some of our ecosystems, our our marshlands, our forests, or prairies that can soak up, you know, massive amounts of carbon without us really having to do a whole lot of extra work. And using that as our baseline. And then we can supplement that with, you know, geologic storage and these other mechanisms that do take substantially more resources, but for the most part, you know, let plants do



DAVID VAGNETTI 23:09

their thing. And okay, that's awesome. That's great. Okay, fracking pumped out. I mean, a

lot during the 2020 presidential debate, because it's a vital part of many state economies. I mean, there's a lot of a lot of features with fracking. I mean, like, the earthquake, that seismic activity, I mean, contamination that it drives, what do we do about all the people who will lose fossil fuel jobs if we transition to renewable grid.

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Sam 23:38

So I think this is a critical problem. Because if you look at this, as a society, we could just choose to sacrifice these jobs and these people's livelihoods and just write them off as part of the necessary transition. But that doesn't sit right with me, I don't feel like we're at a point where we have to make such drastic concessions, where we basically write off a large portion of people whose, you know, their livelihoods do depend on fossil fuel extraction at the moment. So that's what I think any kind of transition like this needs to be, essentially what they call a just transition so that these people are able to continue to prosper even after their jobs are made obsolete. And I think there's a couple ways we can do that. You know, for those who have been in the industry a long time they've put in their years, and we could just buy them out and let them retire early with dignity. We could help people transition to new jobs, but you know, not just saying something simple, like, Oh, they can just go work in an office or something like that. Because you know, you build up these skills, you know, in your life. If you work in the fracking industry, you've built up these skills, and to just be told that that's, you know, no longer useful. You have to do something completely different. You're not going to be as amenable to making the transition then. So I think part of helping people retrain for new jobs is helping them, you know, use their existing skill set wherever possible as much as possible. And not only that, but helping them retrain and creating jobs in the same areas so that they don't have to, you know, move out of their, you know, support system, their friends and family, their ties to the areas where they currently live. So I think we should make those investments even if it costs money to help those people. Because not only is it the right thing to do, you know, these people, you know, have worked their entire lives to help enable our society, you know, it's a shame that it's caused climate change, but we need to be able to make sure that they're taken care of and made whole. And not only that, but if we do have a constructive path forward, for people who would lose jobs, they're more likely to support the transition, and help build the momentum for making it happen. And there is precedent for this, if you look in Europe, you know, there are coal miners unions that are like, you know, we will accept the transition, and will support that if you help us and make sure that, you know, helping us helping our workers transition is part of that plan. So I think there is a big area here where constructive progress can be made. And preserving people, even if these specific jobs no longer makes sense, in our new power grid.



DAVID VAGNETTI 26:17

Some people like I'm off, let me give you an example. I have a couple of virtual assistants. And when I met them, I paid them to study and train them, you know someone's name. Yeah. And it has been a great experience. Because I mean, if you incentivize people to train and study, you get a lot better workers. Exactly. So going back to fracking, are you asking me to give up or sacrifice to help stop climate change? And isn't that gonna scare people away? You just answered it?



Sam 26:50

Well, when I first started this project, you know, someone asked me the natural question, you know, what can I do, personally, to help stop climate change? And I think, you know, framing the question is, you know, what we're asking individuals is the, it's the wrong question, because it's really what we as a society need to do, because, you know, you could, you know, use reusable bags, you could cut down on your energy usage, you could avoid flying as an individual person, ultimately, that's not really going to make that much of a difference, you know, a fraction of a fraction of a fraction of a percent, it's really the collective action that we all tape together and change the systems that are in place to make it more amenable to, you know, a future free of climate change that are gonna, that's really going to get us there. So it really comes down to what we as a society are willing to do collectively, what kind of changes we're willing to make to our current way of living? is the way to look at it, in my opinion,



DAVID VAGNETTI 27:46

again, going back to the sacrifices, exactly. Sure. Why is it seemingly so hard to make dramatic changes in progress and climate change?



Sam 27:55

So I think this goes back. So I mentioned the inertia behind our existing system. Sure. So if you look at, you know, the fossil fuel pipeline, from extraction to processing, the burning, all that has massive investments in fixed capital. So you know, let's say you pull oil out of the ground, you know, you have oil derricks, you have these different kinds of extraction technologies, you have to invest in that those have a usable lifespan that you expect to use for a long period of time to get your money back and make a profit. Same way with petroleum refineries, to the transportation, infrastructure, all those are fixed investments, that if you shut down the industry, overnight, transition to renewables would suddenly become worthless, you know, a plan that you would expect to get other 20 years of life

and profit out of, suddenly, you have to write off as a loss. So you have this natural inertia to maintain the existing system. Because if you're an operator, that is the, you know, rational choice, you want to maximize the return on everything you've built and everything you've invested. So there's this natural pressure to resist change that would disrupt that system, because, of course, nobody wants to lose out on their money making capabilities. So that's really the problem that we have to overcome is that, you know, even if you make, you know, solar cells, cheaper per kilowatt hour, the natural gas power plant, that doesn't really change the calculus for the plant that's already been built, and the person who wants to run that into the ground and maximize their money out of it.



DAVID VAGNETTI 29:27

So how long is it gonna take? I mean, when can things get back to normal?



Sam 29:31

Well, that depends on you know, how serious we are about addressing the problem. If we're really aggressive about it, and I lay out, you know, a very aggressive strategy in the book, I think we could potentially do this rebuilding in 15 to 20 years if we're really dedicated to doing it. That's a short time. It is a very short time, but if you look at is if we look at history, we have done, you know, massive projects in the past. I mean, think back to World War Two, we've fought a war on two fronts basically reorganized our entire industrial ecosystem in the United States to support that mobilized society to do it. And we were able to accomplish that. So it is within our power to do it



DAVID VAGNETTI 30:14

if we choose to do it. But when you talk about for example, am I doing this? Are you talking about the United States in the part of you talking globally?



Sam 30:23

So the book is primarily focused on the United States, just because I am from the United States. So sure, it's, you know, more focused on that. And I think, you know, if the United States leads the way, and then helps build out this infrastructure, it will naturally make it easier to apply those lessons learned to the rest of the world, and, you know, help speed the transition elsewhere.



DAVID VAGNETTI 30:46

Yeah, and developing countries and that kind of thing. Yeah, that will happen. I see that happening. So what's your take on balancing the power grid across the entire country.



Sam 30:56

So when you have a country like the United States, we can basically use every form of renewable energy, just not everywhere. So we have this great southwest region with deserts that are highly amenable to solar power up in the northeast New England, we get a little less sunlight there throughout the year. So it doesn't make as much sense. Similarly, we have a lot of wind power across the plains, but most of the people don't live in those regions are relatively sparsely populated. So the key for making it work across the contrary, is, you know, finding what works best in each region, and then seeing how it can interconnect with other regions where possible. So we have this massive Southwest desert, well, we can push that towards the west coast, where we have a massive amount of population, we have a lot of people living on the east coast. So we can build offshore wind turbines, to really capture a lot of energy there that isn't present for wind turbines, along the east coast on land. So it's all about building what's available nearby, and then balancing that across regions where possible. So we saw what happened in Texas where one region voluntarily cuts itself off from the rest of the power grid, it leads to massive instabilities and problems under extreme conditions. So that's the kind of thing we want to avoid. We want to build in this redundancy. So we can bring power from where it's available to where it can be used. And we want to keep that as close as possible, where possible, just to avoid, you know, having to invest too much in transmission, but knowing that that's going to be a factor going forward.



DAVID VAGNETTI 32:29

And it's a massive project. Yes. Why do you believe the biofuels and hydrogen are not such a great resource of alternative energy?



Sam 32:38

So for biofuels, it really just comes down to the energy density and the kind of infrastructure we'd have to build. So take ethanol as an example, we grow corn, to make ethanol on enough acreage to cover my home state of Wisconsin, massive amounts. However, if you burn all that ethanol, you'll only get about 1% of our yearly energy needs in a perfect system. So really scaling that up to be you know, more than that just isn't really feasible, we need that land for other purposes, not least among them, you know,

serving as a carbon sink for nature to pull carbon out of the atmosphere later, is the same thing for growing trees for, you know, woodfire power plants, that takes a tremendous amount of land to produce energy, that's really not a large fraction of what we need. And when you compare that, you know, we can either cover South Carolina with a forest, and that would provide 1% of our energy, or we could cover a tiny state like Rhode Island and solar panels to provide the same amount, it doesn't make sense to make those kind of biofuel investments on a large scale, because it physically cannot get us to where we need to go. The one exception to that would be LG, you could potentially use that to decarbonize something like air travel, because it requires much less volume. So it's easier to make up that need on a smaller parcel of land. And it's a sector that wouldn't otherwise be able to be decarbonize. So that's generally why I'm not a fan of biofuels for long term energy storage. Now, for hydrogen. This is another, you know, sticking point, you know, hydrogen comes up a lot whenever you're talking about a renewable power grid, because you run some current through water and generates hydrogen. And in theory, you can move it through pipelines. The problem with hydrogen is that it is highly combustible. And you need special infrastructure to be able to movement. So we have all these natural gas pipelines throughout the country, but you just can't put hydrogen through that and expect it to work without any problems. Because the hydrogen molecule is so small, it will actually, you know, diffuse into the metal and other materials, in some cases that can cause structural weaknesses. And you definitely don't want that in your pipeline. So you have to invest in the special pipelines and they do exist. You know, they There are some examples in like the US and Europe, but they're all relatively short and purpose built. So rebuilding that infrastructure across the country, I just don't think is, you know, a wise use of investments



DAVID VAGNETTI 35:11

not feasible? No, it's not. I don't think so. What are the hypothetical action of a climate motivated government?



Sam 35:18

So I think the primary role of the government in this kind of situation, is to really help overcome that inertia that we're seeing. So we were just talking about, you know, the fixed investments that we have in the current system. So the government's role is to come in, and you know, countervail, that inertia to help make the transition, the more preferred option going forward, because if left up to the market, they would likely just continue on with the status quo and not make changes, or at least not changes at the pace that we need them to happen. So you need that extra forcing function. And right now, that really can only come from the government.



DAVID VAGNETTI 35:56

Okay, how are the lessons from history of lead directly applicable to climate change.



Sam 36:03

So I think lead is a great example, because, you know, lead came on the scene, it was widely used in gasoline, it was used as an anti knocking agent in engines. And it's a toxic material, but it was widely used, because it was patentable, and it was profitable. And they wanted to keep it running for as long as possible. And you look at how that, you know, developed over time, you know, once people discovered, hey, there's all this lead floating around the environment, the lead companies naturally tried to bury that they put pressure on it to hide that there was a problem. And that's directly the same thing that happened with climate change, you have fossil fuel companies, they knew that climate change is going to be a problem in the future, and they did their best to you know, obfuscate that put pressure to keep that information down, and, you know, confuse the discourse and resist change going forward. So if you're looking for that, as a model, what really had to happen was that, you know, the government had to come in and have a forcing function that removed lead from gasoline, remove lead from pipes remove lead from pain, to really move it out of the market, and allow us to get to a healthier and state. So that's the same kind of thing here where we have to overcome the, you know, the inertia from the existing fossil fuel industry to really get to that next final state.



DAVID VAGNETTI 37:21

Okay, so how do we respond to climate you at an international level?



Sam 37:26

So that is a, you know, that's a tough question. And, right now, I think that's still under development. Because you have all these competing interests, you have countries that are interested in development, you have countries that are interested in developing climate change. And, you know, you have put three countries in a room and you have four opinions about, you know, the best way to go forward. So if you're looking at the best way to go about it, it has to be constructive. And it has to be looking at a way for how we can actually, you know, make the direct change happen. So whether that's through, you know, providing assistance, subsidies, things like that, to help encourage other countries to make the transition other more protectionist measures, you know, it all comes down to other

competing priorities that as well, because if you put restrictions on foreign products, that could ricochet back on, you know, critical industry in the United States. So it's all about trying to find a balance in the policies that really allow you to make, you know, have some kind of effect in another country to make it so that transitioning is in their best interests, but not so much that you basically force them to to oppose your measure. And that's a tricky balance to find.



DAVID VAGNETTI 38:46

Sure. What do you believe in the face the future of agriculture, the meat in particular,



Sam 38:52

this is one of the sacrifices I talked about in the book is producing meat requires a lot of resources releases a lot of greenhouse gas emissions. So the best way going forward is, you know, if we cut down meat as much as possible, and that's, you know, sometimes hard for me to say, because, you know, last night I had a nice ribeye steak That was delicious. But that's what the knowledge that you know, I shouldn't be doing that every day. I shouldn't be doing that. Probably every week, even I should be, you know, being more mindful to make that more of a, you know, a special occasion type thing, and not have to turn into a vegan to do that. But, well, I don't think we can't rely on everyone going vegan. Exactly, there's online, there's going to be a lot of pushback against that, that's going to be even harder to do than convincing everyone not to fly. So we need alternatives. So there are ways to sustainably produce meat, you know, natural grazing techniques, but that will reduce the supply and make it more expensive, which is you know, another non ideality we have to deal with something We'll have to change in our consumption to really deal with the problem. But we can try to minimize that as much as possible. And that's where I think like these alternative meats that have, you know, come into the market can play a role. Because if you have a chicken nugget, you know, that's not really high quality meat, but it's convenient, it's easy. It's a source of protein. So if you can replace that with these alternative meat products to take that large chunk of the market and decarbonize it, I think that can make a substantial shift.



DAVID VAGNETTI 40:27

Great. Okay, Yellowstone, it's an iconic Wildlife Park, and probably the most visited park in America, that makes it a great common denominator for many people, because they have seen in or have been there. How do you picture Yellowstone National Park in 2100, before climate efforts fail.



Sam 40:46

So if you look at the western United States, you know, California in particular, is undergone wildfire seasons, and, you know, yellow stone, I can see that dramatically changing, you know, in similar ways, as climate and weather patterns change. effort has been put into, you know, rebuilding that ecosystem, you know, introducing buffalo or reintroducing wolves. And I can just see, you know, if we don't take action on climate change, all of that will be for not, as you know, a lot of that land either changes, the water availability changes, the same kind of species, the same kind of environment will be able to be supported. So, you know, I think that's one of the reasons, you know, we have to tackle climate change as if we want to preserve these spaces as they are. And that's one of the reasons why we have to pull carbon out of the atmosphere is to be able to make sure we maintain those in the state, you know, where we have enjoyed them, you know, provided the supervolcano underneath, it doesn't explode in the meantime. But that's a wholly separate problem. So one of the things I discussed in the book, you know, is, would we be willing to sacrifice being able to visit that park, if it's solved the problem? So one of the ideas is you could take all the geothermal activity that that's under a park like Yellowstone, tap into that with, you know, geothermal power plants generate all this renewable electricity, that might, you know, take a huge chunk of our carbon emissions, but it would also, you know, hurt the the cultural and the tourist value for that park. So how do you balance that out versus losing it entirely? So, you know, that's kind of, you know, a prototypical example of, you know, the kind of discussion we need to have as a society and what are we willing to sacrifice to, you know, to prevent the worst possible outcome.



DAVID VAGNETTI 42:44

and a lot of sacrifices.



Sam 43:46

Well, thank you very much for having me. I've enjoyed being on the show. That's great.



DAVID VAGNETTI 43:51

That was excellent. And thank you, Dr. Goodman. If you want to learn more about the sacrifices we must make to provide a healthy environment for our children to inherit the earth. Visit Amazon bookstore and by being carbon neutral before it is gone for good. Thank you so much for being for us with us this week, you have some feedback you'd like to hear. Please leave a note in the comment section below. If you enjoyed this episode and

the three movements or initiative that must coexist. If you're about to defeat mankind's greatest foe climate change. Please share it with your friends on social media using the buttons on this post. Don't forget to subscribe to the show on iTunes to get automatic updates for your Environmentally Concern Nation podcast. And finally, please take a minute or two to leave us an honest review and rating in iTunes. This helps us out when it comes to the show rankings. And I may point out myself I will review every single one of the reviews you give, please review it right now. Thanks for listening and may God bless you. Bye