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Lynn L. Bergeson (LLB): Hello and welcome to All Things Chemical, a podcast produced by Bergeson & Campbell, a Washington, D.C., law firm focusing on chemical law, business, and litigation matters. I am Lynn Bergeson. This week, I sat down with David Rejeski, a Visiting Scholar with the Environmental Law Institute (ELI), to learn more about his involvement in the Project on the Energy and Environmental Implications of the Digital Economy, with support from the Alfred P. Sloan Foundation, ELI, the Yale School of the Environment, and the Center for Law, Energy and the Environment at UC Berkeley. The project is shedding much-needed light on the true environmental and energy implications of the digital economy, focusing on blockchain technologies, sharing platforms, artificial intelligence (AI), and other technologies. We look back at David's pioneering work on the implications of nanotechnology when he was heading up the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars. Now here's my conversation with Dave Rejeski.

David, I am totally thrilled that we are having this conversation. I've been following your career forever. You have been at the tip of the emerging technology sphere forever, but in perusing your more recent writings and activities, I know the environmental impact of the digital economy seems to be the current object of your affection. To start us out, perhaps you can tell us about the digital economy and environmental project, how it got started, who are the players, and what it includes.

Dave Rejeski (DR): It started actually a long time ago. I think in 1999, I wrote a piece that actually appeared on the cover of the *Environmental Forum* magazine, and it was a piece that looked at the potential environmental impacts of e-commerce. I have to think back -- this was 20 years ago, right?

LLB: I know. I'm kind of shocked to hear this.

DR: Every once in a while -- I actually went back and read the piece again. I always do this to see whether I basically had any accuracy at all in my projections. This one is actually not far

off. At that point in time, I think only about seven percent of Americans had bought anything online.

LLB: Wow.

DR: Amazon existed selling books at an enormous loss, right? Alibaba. None of this stuff really happened or was going on then, but I was sort of asking the question. The thought experiment was what happens if, in fact, this gets very easy to do, right? In other words, we make human consumption frictionless. So anybody could buy anything they wanted from anywhere, right? Again, at this at this point in time, we were locked onto the desktop, and we've kind of arrived at that position right now. I mean, people are -- if you've got an Alexa phone in your house, it's got algorithms in it that will ask you, "Hey, do you want to restock whatever you need in your house?" and order it for you.

People thought I was nuts. My colleagues -- I think I was at the Council on Environmental Quality (CEQ) then -- people thought, "Why are you even bothering with this? There's more important stuff to focus on." There probably was then. I never really got a chance to do much with that. I wrote another article with a geographer, same kind of arguments about the coming era of e-commerce. Obviously, now, because of the pandemic, it's gone up even more exponentially than in the past. And I started doing other stuff, as you know, on nanotech and synthetic bio.

So this was kind of a return to questions I had 20 years ago, and we had some money from the Sloan Foundation and that allowed us to start having workshops. And I mean, the first one we did was on the sharing economy because there were things about, "Well, if we get into an Uber, you take seven taxis off the road." And what we found was there was hardly any research outside of what the companies were doing to back that up.

LLB: Right.

DR: I remember the first workshop. I think we had about 12 researchers that came together: economists, environmental scientists, operations researchers. They'd never met each other. They had no strategy. They were very good at putting together small bits of money or a post doc here and there to do the research. And so I think that's what motivated Sloan to start saying, "There's actually a big research agenda here." Despite all of this kind of idea that digitalization was going to be great for the world and is going to save the planet, there's not a lot of really robust research, and it tends to be episodic. There's no research program at any large institutions like the National Science Foundation (NSF). And so that kind of got us started, and we had an initial grant from Sloan. We now get money from the Internet Society Foundation, which was -- the Internet Society was set up by the people who founded the Internet, and they now have their own foundation, and they've started a program on greening the Internet. So we get some money from them.

We actually fund research. We did some work on the energy use of bitcoin or cryptocurrencies. We've got a new project we're running now on the environmental footprint of e-commerce returns. What happens when you buy things and send them back, right?

LLB: Right, right.

DR: And that's largely done by third-party reverse logistics firms. And so it doesn't even flow into the carbon footprint calculations. Some of the business models actually encourage you

to do that. If you've ordered Warby Parker glasses, you get five of them, and say, "You don't like them, send them back. Send us back the ones you don't like." Right? There's many, many more questions. I can tell you it was very difficult to get data, data on what is the digital economy? There's different definitions, but it looks like maybe three and a half to seven percent of the energy use globally is taken up by information and communication technology. That translates into maybe one and a half to three percent of the total greenhouse gas emissions, so it's bigger than the entire global aviation sector now.

LLB: And yet we would never, ever know this, David, which surprises the heck out of me. It's so below radar.

DR: It's close, actually, to the global petrochemical industry, and probably some estimates are it'll go up to 14 percent of greenhouse gas emissions by 2040. That'll put it at half of the transportation sector. Part of it, I think, is just we have this notion that the Cloud is out there, does all this work, right? But the Cloud actually consists of millions of servers, a lot of them in China. And I think bitcoin, as much as I sort of despise the narrative around bitcoin, has made people aware that something's going on. Bitcoin is using more energy than fill in the blank, Denmark or Argentina, whatever it is, right? So I think that this is an area where the environmental folks have an interesting set of challenges. There's not much research, and I think that the whole pandemic has just accelerated all this.

LLB: Right, and brought it more, I think, personal and closer to home for people to actually appreciate that there may be a consequence to seeing all of the Amazon trucks on the road. And returning products, right?

DR: Yes, I remember last year or the year before, even before the pandemic, just wandering through Greenwich Village, and there were just piles and piles of boxes on the stoops. People in condos -- they have to actually redesign the condos so they have a room for all the boxes. I think that there is this whole issue of what is the impact? How do we quantify it? And from a policy standpoint, how do we deal with it? Where are the intervention points? And who in the government is beginning to think about this? Last year, the year before, I basically made a recommendation that EPA should set up an office of algorithmic governance, that an awful lot of environmental decisions aren't going to be made by humans anyway. They'll be made by algorithms that maybe are trained by humans, but you're not going to see what's going on. I think a lot of this, as you said, it's invisible, almost, right?

LLB: Well, it's invisible, and the narrative has been so disassociated from the reality. I share your view that when ride sharing, for example, really was much more on the ascent, the perception was, and perhaps still is, that Uber and Lyft and other ride-share technologies and platforms ultimately are more sustainable than jumping in your car and doing things on your own. And I know, just coincidentally in the *New York Times* [yesterday], October [17], there is an opinion piece on how -- it reads "For Uber and Lyft, the Rideshare Bubble Bursts" as it talks about how the reality is very different from the perception. Recognizing that deadheading, driving around without a passenger, is actually more energy-inefficient and generates more greenhouse gases than multiple trips made by personal drivers. But without the data, without the review, and without the research that happily you and others are funding right now, it seems that the perception is just very disconnected from the reality, and I honestly don't know why that is, David.

DR: I think part of the problem we ran into is that a lot of the data that you need to figure this out is proprietary. The companies have it, and it's not being shared. We're funding a project now that looks at whether the existence of Airbnb induces more travel. The fact that we've

made it easy to do an Airbnb, we know from some of the data, our initial data analysis, is actually beginning to move outside of the urban core. Public transportation has gone down, so people that are going to Airbnbs may be using more transportation, right?

But it's very, very difficult to get that kind of data from the companies because it's proprietary. It's a key part of their business model. So we know from the researchers that that's probably one of the biggest barriers. We did a project in Los Angeles (L.A.) to try to figure out what keeps Lyft and Uber drivers from getting electric vehicles (EV), because they drive a lot. So if you really wanted to reduce their impact -- they're driving five or six times more than the average person per day -- and we just basically set up surveys and got a lot of students into Lyfts and Ubers with tablets and did a survey and found out that there's a lot of misconceptions. There's this whole issue of range anxiety and not enough charging. Lyft actually has a subsidy program for EVs that most of them didn't know about. Some of that data has now been given to the California Air Resources Board. Just this whole idea of how do you change the behavior of some of the people that are intense drivers of these ride-sharing systems hadn't really been researched. There's a need for a lot more research, and I think that it just occurred to us, even as we wrap up the research, that there's still a lot that needs to be done, especially on the -- not just the engineering question of how much data is being used by servers, but what happens when we put a device in someone's hand, our digital lives.

LLB: The diversity of the projects that -- if you go to your website, at www.eli.org -- I was shocked and just completely amazed at the diversity of the projects you're looking at. It involves best practices for analyzing indirect energy use of blockchain, ride-share electric vehicles and ride hailing, empowering citizens to use private data for decision making, carbon footprint of Airbnb. How many partners are engaged in this research? When did you actually begin it? Because it sounds like you been thinking about this literally for decades, David. But now there is a more systematic approach to identifying some of the larger technologies that have huge energy and environmental implications, and how do you even define a metric for assessing it, let alone calibrating it and then sharing that information in a way that makes the public more cognizant of the implications of their actions in our digital economy?

DR: One of the things we do is we have actually used some of the funding to design our new website. So I'll give you the new website, which is much easier to navigate. It's called networkdee.org. It's a network for digital economy and environment, but networkdee.org, that's the new one, and that'll give you a lot of the background, the research. The partners here that we have are Yale, it's the school for the environment [School of the Environment]. Remember it used to be the School for Forestry and Environmental Studies, and UC Berkeley, the Center for Energy, Environment, and Law, I think; I always get this mixed up [Center for Law, Energy & the Environment]. The idea was to have a West Coast presence, a DC presence, East Coast presence. And we've been doing this together now for, I think, four years.

LLB: Wow.

DR: Workshops, but also again, trying to actually take money and fund projects. Most of the funding has been domestic. The Internet Society allows us to fund some foreign projects. So we actually just put out a new request for proposals for research that looks more on indirect effects and rebound effects. What happens if we make it very easy for people to do something, and they just use more of it, right?

LLB: Right, exactly. It's human nature.

DR: But one of the things that we did was we did a pretty extensive analysis of who else was doing something like this. And there are just not a lot of organizations that have this kind of an explicit mission.

LLB: Just providing that mapping service is likely to make it more cognizable and perhaps efficient to combine resources.

DR: So part of it, I think there is a much greater -- I think Sloan, and partnering with the Internet Society Foundation -- I think there's also a much greater willingness on the part of philanthropies to pool money to do something like this, either with each other or potentially with government funders.

But I do think you need an honest broker. You need kind of an independent voice because a lot of the numbers and the quantification have been done by industry or, you know, they've been done by McKinsey that's funded by industry, or whatever. And so you don't have a lot of independent kind of research going on that can inform decision makers or just helping people make more, I think, rational choices, whether they're businesses or consumers.

LLB: Exactly. One of the areas that I focused on looking at some of the research that's coming out is recognizing that blockchain reportedly has the potential, I think, by all accounts, to revolutionize supply chain sustainability. I was surprised to learn that Chipotle uses it for food safety, Wal-Mart for traceability, just to name a few. But the computational power consumes, I am sure, just hundreds and hundreds of megawatts of energy. Higher energy consumption means higher carbon emissions. How is the project addressing the sustainability of blockchain technology? Putting aside how successfully it has been utilized today -- because there's quite a lot of literature out there on how the response to date has been somewhat underwhelming -- but I would imagine it's on the ascent and that users of that technology would be better informed to understand the energy consumption implications of this emerging technology.

DR: Yes, I think one of the reasons we funded this one research project on blockchain is we wanted to get a sense of were the estimates any good, right? As you said, there's a whole bunch of estimates out there. And if they did have weaknesses, how do we make them better, right? And this is a classic thing. It occurs all the time when we're focused on the environmental performance of anything. How do we measure it? How do we verify it? What are the best practices? How do we get industry to adopt those things? And so what they found out was that there weren't a lot of best practices. The estimates were all over the map. Some of them were top-down ones, some of them were bottom-up, some were hybrids. And the biggest mistake, I think, for most of the estimates were the system boundaries. That's a classic mistake, right?

We leave something out, and that piece we left out actually accounts for a lot of energy, and that's why we did this sort of best practices guideline to try to see if we could get the people in the industry to adopt better ways of measurement. I think you do see right now -- the other thing I would say that always has been a little bit upsetting -- is bitcoin is a type of blockchain. It's not blockchain, right? And as you went through probably that inventory we have, you saw that there are hundreds of uses. So you can set up potentially very efficient carbon trading markets. You could do supply chain management. You can do recycling of plastics with blockchain. Most of those, I think, are not well understood. People just say, "Blockchain is bitcoin."

LLB: Yes, there is that kind of reflexive identification --

DR: -- And it's bad.

LLB: It's all negative, right.

DR: It's all negative. Right now, I think there are -- it changes almost daily -- I think there's almost 8,000 cryptocurrencies.

LLB: Wow. I had no idea.

DR: And so you do see, I think, in the cryptocurrency area, other companies that are quite aware of this. There's this problem. One of them is Algorand that has the token; it's not bitcoin, it's called the Algo, but they use a different way of verifying the currency that doesn't require as much energy. There's different ways of doing this, so it's much more -- it's less energy intensive. And they're also starting to do things like working with another blockchain company, I think called ClimateTrade, so that when you actually use an Algo, it automatically sets up a contract to offset your emissions.

LLB: Innovative.

DR: One of the beauties of the blockchain is you can build in what people call smart contracts. I think there's a greater sensitivity to this. I think it's just been a matter of bad press and press that just doesn't go away. Yes, you probably remember a lot of this about data centers.

LLB: Right.

DR: When people started building huge data centers, it was going to crash our energy system, and it was going up at 25 percent per year. And now, even though the whole data center infrastructure has expanded immensely exponentially, the increase might be three or four percent per year, and a lot of that energy is coming from renewables now. So essentially, I think the negative press coverage actually motivates industry to do something. Or at least there are a bunch of people that want to be first movers on the environmental messaging that may try something new and different, that others will adapt as you go across the bell curve.

LLB: There must be kind of a *déjà vu*-ness to all of this, David. You've spent a career identifying emerging disruptive technologies and how traditional governance systems are so far behind in quantifying -- first off, identifying, and then quantifying, and then addressing the environmental and ecological implications of those technologies. And the same holds true here. We have these enormously disruptive technologies at play, blockchain and AI and everything that we've been talking about. And my sense is that the implications of these technologies and their general disruptiveness for good or for bad -- I'm not making judgments here -- but there's a footprint. At least penetrating the public's consciousness about what that footprint is, quantifying it, and then having it as an element in decision making generally is something that we would all be better off in thinking about. The federal government is probably very, very far away from making this a cognizable component of the environmental and ecological landscape. That's a question, not a statement. But assuming that there is a growing recognition that this is a factor, is it being harnessed in any meaningful way at the decision making policy level?

DR: I think the government obviously has -- it's interesting because the government, as usual, and the government doesn't get much credit for this -- probably it's funded an awful lot of

the basic research that all of this is built on, right? You know, we kind of forget about that piece of the science and technology evolution path quite often. Some of these things appear and they appear like magic, right? I mean, you think about the new COVID vaccine. You know, there's probably a decade, decades of research into messenger RNA that people forget about. And some of the early research was, of course, funded by the National Institutes of Health. And there are people who struggled trying to get people to pay attention to this, and they didn't get tenure et cetera. And finally, it's there, and we're able to use it.

The other thing that's I think interesting was those vaccines depended on nanotechnology. We talked years ago about these. They don't exist in isolation. There is this convergence and this ability to take the messenger RNA and deliver it into our bodies using lipid nanoparticles is what made them possible. But again, it appears kind of like magic. So I always think that the government is actually in a very good position to see these things because it's funding all of the basic research. And the basic research can manifest itself in lots of ways, but it has a fairly deep view into what's going on. It had it with nanotech; it's had it with a lot of technologies, the Internet of Things, a lot of that. These tiny sensors were built on early work by DARPA [Defense Advanced Research Project Agency] on mesh networks. I think the problem quite often is I don't know who's responsible for seeing it, right?

LLB: Right. Well, we're seeing it. And as we've talked about, you know, the federal government has a huge role, and governments in other countries as well, have an enormous role in the development of the thing. But with respect to the *implications* of the thing, not just the *applications* of the thing, that's where I think your writings with regard to a more total strategy or holistic approach for identifying all of the implications and of the applications. And as you've written in the more recent past, the ascendancy of the roles of environmental big data and community platforms, what they play, the role they play as drivers in shaping environmental behaviors and performance. How would you take that thought of this total strategy and project it out with regard to these emerging technologies with regard to blockchain and the economies that we've been talking about in the digital space?

DR: Part of the issue is that we're not -- this idea of a total strategy for the total environment -- that actually was a quote from Edmund Muskie in 1970 on Earth Day.

LLB: No kidding!

DR: Yes, I thought that was kind of -- and of course, we don't have a total strategy, but I think part of it is I don't think we're organized to do this very well. I remember, I think it was 2008; I co-wrote a piece with a bunch of people arguing that the U.S. government needed to set up an Earth system science agency, so an agency that was responsible for the Earth as a system. And we didn't need to create a new agency; we would do this by combining NOAA [National Oceanic and Atmospheric Administration], USGS [U.S. Geological Survey], and the part of NASA [National Aeronautics and Space Administration] that ran the mission to planet Earth. So all of the people that were responsible for all the data and monitoring observations of the Earth as a system. It didn't get very far, but --

LLB: Right. It's a good idea, though.

DR: When you think about the Department of Homeland Security, where you remember we merged, I think it was 16 or 17 various departments, when there was a threat to the homeland, right? And there's a threat to essentially the global homeland now. I still think that we're not optimally organized for this, and it's difficult now to begin to think about it,

but it's not impossible. When I was working in the White House science office [Office of Science and Technology Policy], I always walked around, and I always wished -- I call it the Department of Unintended Consequences.

LLB: Right. The world in which we live.

DR: Yes, just give me five people whose job it is to think about them, right? And they could be positive ones. They don't have to be negative ones, but it's almost like no one's job. The Office of Technology Assessment [OTA] went away. Good news, obviously, is a year, year and a half ago, Congress gave the General Accountability Office (GAO) more money to do some sort of tech assessments. And they became, after OTA's demise, kind of the substitute for OTA. But I think there's an enormous need for something like that, that's seen as independent, that can talk directly to the political system, and essentially that kind of function reproduced in the agencies themselves. I've always been impressed with where NASA has an office for planetary defense.

LLB: I didn't know that.

DR: And their job was to think through what would happen if astronauts came back with some unknown virus. Or what's our responsibility if we go into space that we don't take our bacteria and viruses and things that could be obviously dangerous to other living or whatever it is, the systems out there outside of the Earth? So I think that they're interesting models. I don't think it takes a lot of expenditure -- as I say, just a group, an EPA or some of the agencies that focus on algorithms would be very, very useful. Right now, we tend to think of -- I think our focus on Big Tech, especially big information tech, is to deregulate, basically to hack it apart and go after them with antitrust. And let's basically split apart Facebook. I think the environmental folks need a much more nuanced approach.

I think the thing that struck me -- I used to own a Volkswagen Diesel, and you obviously probably remember the Dieselgate situation. And I thought, here's a car where the algorithm was deceiving the regulators, right? And I thought that would be -- obviously, we went after them with lawsuits. But I thought that would be a wakeup call for the environmental folks, that you had a car that was trained to do deception. And it was a machine-to-machine system where the car pulled up to be tested. It knew it was being tested, changed the emission parameters, passed the test, and drove away.

LLB: Right.

DR: And I said, "Wow." This was a negative example, but I think that's the world we're moving into is an awful lot of the decisions that occur -- whether they're the logistics decisions or how we make things -- will be made by algorithms that are largely invisible. And I think that requires some thinking through by the environmental folks. I'm not sure you regulate that. I think the first thing is just an awareness of it. And I don't see lots of discussions.

LLB: No, I completely agree. And that's one of the points I wish to make here and to draw attention to the project in which you are with others engaged. Because the enormity of the issues that we're talking about -- energy consumption, the environmental footprint occasioned by the digital economy -- I think is not recognized as a very significant issue. There's a lot going on right now with Facebook and Instagram and all of the other social media implications that have been so much in the news these days. But that's a very different angle. What we're talking about here is just the ecological and environmental

aspects of these very disruptive, emerging, if not dominant, technologies as part of the new economy in which the world is living.

So raising awareness of it is probably the first step in a long sequence of events to start managing it in a way that would enable businesses, consumers, and others to make just informed decisions about how they are running their lives and the decisions they make as part of being humans, right? That is just not a very relevant part of the calculus right now. So the project that you and your partners are engaged in is just enormously important. It's very similar to some of the conversations we've had over the years, David, with regard to the fundamental nature of nanotechnology, for example. All of a sudden it kind of just emerged on the environmental policy scene in a way that didn't really -- I think caught people by surprise, to be honest. And then it just took off. Some of the other projects in which you've been engaged over the years: synthetic biotechnology, biotechnology, specifically, all of these "-ologies" have been a very core part of the human experience. And yet thinking of how they evolve and what their implications are are always lagging very, very far behind in the human consciousness. Do you have any reason to believe that the digital economy and the environmental and ecological impacts will be any more prominent than any of these other technologies over the years?

DR: It's hard to tell. The one thing I think that's positive is I find that this kind of work resonates with young people. Maybe not people our age, I'm not going to estimate our age.

LLB: No, but it's true that the digital economy is thought -- again, that goes into the perception that it's young, it's youthful. It's kind of environmentally neutral, which, of course, is not true.

DR: Those people that are digital natives, those are people that actually have been, I think -- the young people, when we actually broke down the research that we did or funded, and we weren't, basically we actually, I think, had people from 12 different disciplines. It was a 50-50 gender split, which was interesting, right? Because in technology, it always tends to skew male, white male. And also it skewed young. And my hope is that there's a whole bunch of people that grew up with the technology that say this is part of our lives, and we understand it, but we have to be more considered about what the long-term impacts are. I think I went through a tedious process, but interesting, the entire 400 recommendations of the International Energy Agency about how we get rid of 34 gigatons of carbon by 2050, and there was virtually nothing in there on digitalization.

LLB: Really? Wow.

DR: The one -- we found some stuff on smart grid. And I think this is an area where digital technology can have a huge impact, not just grid modernization, but it wasn't something that I think, does it have the same impact as the steel industry? It's three gigatons a year. Well, it could, right? I just don't think there's a lot of attention. But I'd say every week or two, I get an e-mail from somebody that is finishing their master's degree or that wants to work on a doctorate that says, "This is really interesting stuff. Who can I study with?" Right? Essentially, there's no field there.

What happened with nanotech, synthetic bio is, the NSF, the Department of Energy, they made a long-term commitment, which went out over decades to build a field, right? Where somebody could actually study this when they finished their studies and had a Ph.D., they could get a job. Maybe they could get tenure someday, or they could go into industry. So this whole idea of field building where you have a field where there are people who that's

their job. I think about the environmental, ecological impacts, the environmental justice impacts -- whatever it is -- of the digital economy. I think that's what it would take. You need almost somebody like NSF or one of the large agencies to step up and do what they did for other areas where they built a whole new field. And then you need peer review journals for that field. You know the entire ancillary environment that you have to put around it. So you actually create this kind of nurturing environment for the science.

LLB: You're so far advanced on many different levels, David, in how you see things. That's why you're the thought leader that you are, but it calls to mind when you were with the Woodrow Wilson International Center for Scholars working with the Science and Technology Innovation Program. You and your colleagues there were very much involved with promoting to the public the fruits of your labors and the results of your research. You did a lot of public outreach with National Public Radio. You recorded at department store cosmetic counters, and you got an article into *Elle* magazine, for example. Given the ease with which information is now communicated through social media -- Facebook and YouTube and Twitter -- and the God knows enormous opportunities for sharing information and getting information out there, do you think the scientific community could or should do more to promote these types of concepts, which are an interesting mix of consumer awareness and the environmental implications of a digital economy? Do you think the scientific community, the business community, all communities should be doing more utilizing social media to get this information out, so it is less a foreign new concept and more something that we think about before we pick up the phone and/or tap into our computer a new Amazon order, for example. Should we be doing more?

DR: Yes, I think as you said, obviously, the social media landscape allows you to transmit a lot of information, also as we know, a lot of misinformation, right? That's the downside. If I look back at what we were doing back during the Wilson Center time, I think we had -- even the *Elle* magazine article, which people had chided me about endlessly because we were supposed to publish in foreign policy and all of these reputable journals. That was --

LLB: Is that right? You were given grief because of that?

DR: Oh, yes, yes.

LLB: I had no idea.

DR: I was very proud of that article.

LLB: Well, you should have been!

DR: Because it reached a group of people that were questioning that nanotechnology was finding its way into cosmetics and sunscreens, as you were --

LLB: Oh, absolutely.

DR: And they actually did a really -- one of the things that struck me then is that you had then people that were invested in long-form journalism, right? So I remember almost two full pages in *The Washington Post* on nanotech that was written by Rick Weiss. He could never get that kind of space anymore. The *Elle* article was well researched. It was three pages long.

And I think one of the problems is you're dealing with these kinds of things. It's very difficult to do science by sort of satellite journalism. I think the other thing that's happened is just people are kind of -- especially around climate -- this kind of emergency journalism that we're in the middle of a crisis, a catastrophe. I think people are almost overwhelmed. I think there was a study that was done in 2016 or 2017 of five major newspapers, and they were publishing seven to 20 articles on climate every day. And then you load the social media feed on top of that. So I think the other thing is people are frightened; they're scared. They don't -- and I think once you begin to focus on this as potential calamities, it basically makes it much harder to focus on compromise politically, right? And in dealing with just the climate area, it's very difficult to get away from the kind of calamity journalism.

Even the people like Elizabeth Kolbert, the new book she put out, *Under a White Sky*, talks about what used to be called radical technology, right? Basically, genetically engineering plants using gene editing, using aerosols in the atmosphere to change the albedo of the Earth. I think it's very, very difficult to find anything that's kind of balanced. And when I talk to young people, a lot of them are just, you see that -- Fridays for Future, right? -- I think scared, depressed, angry. So I think it's a very different kind of media landscape than what existed back even when I was 15, 20 years ago when we were doing work on nanotech.

LLB: No, I agree that's entirely different. But to the extent that some of these concepts are so relatable at a personal level: ride share, Airbnbs, AI. These are topics that are very much a part of our lives, which you could say the same about nanotechnology, that people are not as cognizant of the fundamental nature of nanotechnology and how pervasive it is in the products that we buy and the systems that we use. But given the easy availability of information distribution and the relatability of these digital economy platforms, a simple thought is that the work that you are doing with the Yale School of the Environment and your partners on this project, you are doing an extraordinary service for just communicating the awareness of these platforms, how pervasive they are and how they are not environmentally or ecologically neutral. And to your point about needing an honest broker, independent information that is generated by third-party experts that can present the information in a neutral way to allow people to make decisions about the habits that they are developing as humans.

So it's a fabulous project, David, and once again, you are both way ahead of others and to the extent you started this back in 1999, is just another indication of what an incredible thought leader you are. Be helpful if you could tell our listeners once again what the e-mail address is or the web page address of all of the projects that you and your colleagues are now funding because I think the diversity of the initiatives, the research, and academic work that you are doing in these areas is really extremely comprehensive.

DR: Sure, glad to do that. On the web, it's just networkdee.org. Once you get in there, you'll see, you can look at different research topics. We do work on AI, we do work on blockchain, the Internet of Things, sharing, and e-commerce platforms, and you'll see breakdowns of the research. There's an inventory that we have, which I think you accessed, of just interesting ways blockchain's being used. And obviously, there's an e-mail list people can just send us an e-mail and sign up for notifications. We are -- let's just say that the website's brand new, and we're kind of expanding the use of it, so glad to get more people signed up to and get them onto the website. Because all of this stuff that we do is public domain. It's all being shared.

LLB: Yes, and it's just a real treasure trove of information. I did take a look at the blockchain technology and the susceptible supply chain, theoretically exploring adoption barriers and just learned a ton. I hope our listeners will log on to that website and participate in all of the information that is being amassed here. Does ELI, or does the project generally have any upcoming programs you wish to promote here, David?

DR: We are putting out -- we're actually sitting on, I think, $150,000 of research funding. So we are soliciting proposals for a new set of projects that focus on sort of indirect effects of the digital economy, such as rebound effects, some of the more complex ones. We're also doing some -- I think you'll begin to see some results of the projects that we have funded over the last year, coming out next year on reverse logistics and some of the impacts of Airbnb. So I would say, stay tuned. Visit the website. If people have ideas they'd like us to look into, we're -- send them to us. We're more than glad to expand our network of collaborators or partners.

LLB: Great. One last question. You are a former member of the White House Office of Science and Technology [Policy]. Has the new Administration, the Biden Administration exhibited any particular interest in undertaking more of these initiatives, or at least trying to quantify more precisely the environmental and ecological impacts of the digital economy?

DR: Not that I'm aware of, but I think they obviously -- I think one area that's kind of overwhelming them is just the pandemic.

LLB: Of course.

DR: It's been interesting to me that the White House science office hasn't been particularly visible, even though Eric Lander, who is the Science Advisor to the President, is actually a world-renowned geneticist. That's the field he made a name in, and he's I think a fairly good communicator, but I think that's what's consuming them and also, I think economic recovery, climate change, you name it.

LLB: There's no dearth of priorities, for sure.

DR: Yes. And I think it's very difficult to get something like this on the front burner. I would hope that EPA or some of the other agencies would step up and try to do more in this area. I think it's an enormous opportunity for EPA, both in terms of using the technology, but also mitigating or addressing any of the potential negative effects. That was always the one sentence that we used to describe what we were doing in a lot of the other "-ologies." First, we want to maximize the benefits and minimize the risks. I think that's sort of the situation here.

LLB: Well, David, I wanted to thank you for this conversation. Thank you for the pioneering work you're doing with respect to the digital economy, and thank you for being the thought leader that you are because your contributions in this space over the years have just been extraordinary. I think you're one of the smartest guys on planet Earth, and I've really appreciated you being with us here today.

DR: Thank you for inviting me.

LLB: My thanks again to Dave for speaking with me today about the energy and environmental implications of the digital economy and other aspects of Dave's storied career in emerging technologies. Dave's many contributions to understanding the environmental implications of

emerging technologies are fascinating, essential, and always many steps ahead of other scholars. And I'm very grateful to David for sharing his thoughts with us.

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