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Committee on Environment
and Public Works

Subcommittee on Clean Air, Climate, and Nuclear Safety

Washington, D.C.

AIR, CLIMATE, AND ENVIRONMENTAL IMPACTS OF CRYPTO-ASSET MINING: LEGISLATIVE HEARING ON S. ___, THE CRYPTO-ASSET ENVIRONMENTAL TRANSPARENCY ACT OF 2023

Thursday, September 29, 2022

United States Senate

Committee on Environment and Public Works

Subcommittee on Clean Air, Climate, and Nuclear Safety

The subcommittee, met, pursuant to notice, at 2:35 p.m. in room 406, Dirksen Senate Office Building, the Honorable Edward Markey [chairman of the subcommittee] presiding.

Present: Senators Markey, Ricketts, Carper, Whitehouse, Lummis.

STATEMENT OF THE HONORABLE EDWARD MARKEY, A UNITED STATES SENATOR FROM THE STATE OF MASSACHUSETTS

Senator Markey. Good afternoon, everyone. I am pleased to call the Subcommittee on Clean Air, Climate, and Nuclear Safety to order for a legislative hearing on the Crypto-Asset Environmental Transparency Act, which I have introduced along with Senator Merkley and Senator Sanders.

This is our first subcommittee hearing of the year, so Senator Ricketts and I are going to begin, as they say in Casablanca, a beautiful relationship over the next two years.

[Laughter.]

Senator Markey. We are looking forward, of course, to working with Senator Carper and Senator Capito as well. We are looking forward to partnering with them and their extremely helpful staff. Over the course of the next two years, there will be many important issues that we will be asked to consider.

We welcome our witnesses. We appreciate your willingness to appear today.

Today is going to be the first Senate hearing ever held on the environmental impacts of crypto-mining. They may be mining digital assets, but their activities have real-world consequences. This is an emergency, an urgent issue. Congress needs to be proactive and reactive in tackling it.

The market size of the global crypto-mining industry was

estimated at $2 billion in 2022, more than one-third of which is in the United States. That industry is forecast to nearly quadruple over the next 10 years, which means its threats to our environment, health, communities, and climate are set to explode.

Bitcoin mining consumes as much power globally each year as the entire Swedish economy. In the United States, carbon dioxide emissions from Bitcoin mining are equivalent to the annual emissions from as many as 7.5 million gasoline-powered cars. Right now, Bitcoin mining in the United States uses as much power as we need to light every single home in our Country. That demand on our grid is only going to grow.

That is an amazing number, that Bitcoin alone consumes as much electricity as every light on in our Country every day. We face an urgent climate crisis, which the Biden Administration has committed to addressing by reducing greenhouse gases by 50 percent by 2030. We know we need to tackle emissions from many different sectors of our economy, and I am sure we will have hearings on these sectors as well.

But our first hearing is focusing on the crypto-mining industry, because it deserves the spotlight. It has grown explosively in the United States over the past two years. It is extremely energy intensive. We have seen it harm the general public while enabling the creation of heavily concentrated

wealth in our Country.

We are not here to debate the pros and cons economically of crypto currency. We are here to discuss what the impacts are environmentally in our society and what we can do to reduce its impact. As our expert witnesses will explain, Bitcoin was the first-ever crypto asset, and relies on a process known as proof-of-work mining. Crypto miners use large banks of computers that suck up huge amounts of energy to run computations and are awarded new Bitcoins as a result.

Every 10 minutes, a miner will generate Bitcoins a reward that are currently worth nearly $140,000. As the value of Bitcoin increases, there is more incentive to run more computers, consume more energy and mine more Bitcoins. It is an energy arms race for the digital era.

Bitcoin miners have already had a direct impact on our climate by bringing mothballed coal- and gas-fired power plants back online to power their operations. But it is more than just climate issues. Mining equipment creates significant amounts of electronic waste. Mining requires huge amounts of water for cooling and power generation. And residents from across the Country have provided me with testimony of devastating noise pollution from neighboring Bitcoin mining facilities.

With an environmental impact like this, Bitcoin is more like digital coal than digital gold. The commodity is virtual,

but the harm is tangible. While the Bitcoin mining industry claims that they can actually be a boon to the environment, saying that they can capture and burn vented methane to power their operations, or that they can actually improve grid stability, we don't have the transparency which we need to vet those arguments to see if that assertion is true.

But we do have real-world examples of how the industry is already creating real consequences for communities. That is why we are here. The Crypto-Asset Environmental Transparency Act would mandate a detailed EPA-led study of the environmental impacts of crypto mining. The Act would also require crypto miners to report their carbon dioxide emissions under the EPA's Greenhouse Gas Reporting program.

The people who profit from Bitcoin mining can't be left to grade their own homework. A take-home exam that you grade yourself almost always gets an A, that is just human nature at work. So we need someone to check that work. We need independent, trustworthy, and accurate statistics, so that homework gets a grade that is independent.

I look forward to discussing how the study and reporting in my Crypto-Asset Environmental Transparency Act can help inform Congress and the general public about these emerging issues. All I can say is I am glad we are going to be able to have an active subcommittee this year. I am looking forward to

partnering with the Ranking Member on the subcommittee, Senator Rickets. At this point, I would love to recognize you for your opening statement.

[The prepared statement of Senator Markey follows:]

STATEMENT OF THE HONORABLE PETE RICKETTS, A UNITED STATES SENATOR FROM THE STATE OF NEBRASKA

Senator Ricketts. Thank you very much, Mr. Chairman, and thank you for calling this subcommittee hearing. I am grateful for the opportunity to be the Ranking Member on the Subcommittee for Clean Air, Climate, and Nuclear Safety.

I look forward to working with you and the other members as well, members on each side of the aisle in EPW. I understand that you had a very successful last year with a lot of bipartisan legislation coming out.

I also want to welcome our witnesses that are joining us here today. I appreciate you all taking your time to be able to be here. Especially I would like to recognize Courtney Dentlinger, who made the trip from Nebraska to come and testify. She works for Nebraska Public Power District. You may not know this, but Nebraska is one of the only, well, I think we are the only public power State left in the Country, completely a public power State.

During my tenure as Governor, Ms. Dentlinger actually led our Department of Economic Development. She was so good at her job that we actually won two Governors Cups for the most economic development projects per capita of any State in the Country, which not only was great for us back then, but she also knows a lot, she is an excellent choice to talk about how to

market Nebraska both nationally and globally, as she helped us win those Governors Cups and helped develop job opportunities in Nebraska.

So today we are here to discuss an emerging industry, crypto-asset mining. I am particularly interested in this topic as to whether this industry could result in more economic development for the State of Nebraska and across the Country. While crypto-asset mining may be a relatively new topic for the Environment and Public Works Committee, it is actually not my first time interacting on this topic and the crypto-economy. When I was Governor the Nebraska legislature passed and I signed a Nebraska Fiscal Innovation Act into law. This law provided an avenue for financial institutions to invest in our State and benefit from this emerging sector.

According to CNBC, my home State of Nebraska was actually named the number one State for developing a crypto economy in 2022. I am proud that new businesses and new job opportunities related to the crypto-currency industry have either located in Nebraska, or are considering coming to our State.

When businesses are looking for a place to open their doors, what they are looking for is a business-friendly environment, some place that they are being welcomed. They are looking for regions also that can help them keep their costs low. For crypto asset mining, a key variable of course, as the

Chairman pointed out, is electricity, one of the key variables of their operating costs.

That is one of the reasons that these businesses are choosing Nebraska. Our electricity rates are among the lowest in the Nation. Nebraska's average price for electricity per kilowatt hour in 2022 was just 9.84 cents.

In addition to favorable energy prices, the people in Nebraska know best how to succeed by getting government out of the way. That is one of the things I talked about, a business-friendly environment.

So I am interested in hearing on this topic we are discussing today about how we are treating one industry, the crypto-asset mining, differently from other electricity consumers. Crypto-asset mining is hardly alone in being an industry relying on large data server banks. Finance, technology, government, academia, many others use significant amounts of electricity to power their computing needs.

We should be providing the tools for open competition in a free market by not allowing politicians or bureaucrats in Washington, D.C. to pick winners and losers. When the Federal Government targets an industry it has caustic consequences, especially for an industry just beginning its development. Overreaching laws and regulations can drive emerging technologies overseas. That often goes to countries that have

fewer environmental regulations than the United States, which means you are actually adding to greenhouse gas emissions. This also means that we are losing jobs here in America.

I look forward to hearing our witnesses' testimony to explore discussions and opportunities related to crypto-asset mining. With that, Mr. Chairman, it is a pleasure to be serving with you. I yield back time to you.

[The prepared statement of Senator Ricketts follows:]

Senator Markey. The feeling is mutual, thank you.

Thank you, Senator Ricketts. Now we are going to turn to our esteemed panel of witnesses. We are going to hear them in order. First, we will hear from Rob Altenburg. Mr. Altenburg is the Senior Director for Energy and Climate at Citizens for Pennsylvania's Future. Before that, he worked for the Pennsylvania Department of Environmental Protection, studied law at Widener Commonwealth Law School and he is also a combat engineer company in the United States Army Reserve.

Next, we are going to hear from Dr. Anna Kelles. Dr. Kelles is the Representative from New York State Assembly's District 125. Her district covers Tomkins County, where she was born. She earned a dual bachelor's degree in biology and environmental studies at Binghamton University, and a Ph.D. in nutritional epidemiology from the University of North Carolina at Chapel Hill.

Finally, we are going to hear from Courtney Dentlinger. Ms. Dentlinger is the Vice President of Customer Services and External Affairs at Nebraska Public Power District. She is a native of Battle Creek, Nebraska. She earned a bachelor's degree in political science, international studies and Spanish from Wayne State College and a juris doctorate from George Washington University here in Washington, D.C., in addition to all the very nice things that Senator Ricketts said about you.

We welcome all of you. Thank you for testifying, and we will now in order recognize you for your opening statement. We will begin with you, Mr. Altenburg.

STATEMENT OF ROB ALTENBURG, SENIOR DIRECTOR OF ENERGY AND CLIMATE, CITIZENS FOR PENNSYLVANIA'S FUTURE

Mr. Altenburg. Thank you, Chairman Markey, Ranking Member Ricketts, for having me here today. My name is Rob Altenburg. I am the Senior Director of Energy and Climate at Citizens for Pennsylvania's Future. We are a membership-based non-profit environmental advocacy organization.

I have been working on energy and environmental issues for over 30 years. I am here today to share why I am concerned about Bitcoin mining and other related proof-of-work crypto-currencies. That requires a little bit of background.

First, for all its high-tech image, Bitcoin is based on a simple idea that has been around since the 1980s. It is called a block chain. It is basically an accounting ledger where each page or block records Bitcoin transactions.

Part of what keeps this ledger secure is that creating new blocks is very, very difficult. Finding or mining a new block is a guessing game where the odds of being correct are less than one chance in a hundred billion trillion. Much, much lower odds than winning the lottery.

And the odds get worse the more miners join the race. The winner, the first one to mine a valid block, is rewarded with newly mined Bitcoin currently valued at over $140,000 with no prizes for second place.

To be competitive, Bitcoin miners use racks of special purpose computers that make trillions of guesses, hundreds of trillions of guesses every second. Each of those computers uses more than three times the amount of energy as the average household and a single miner might run tens of thousands of them 24-7. Altogether, Bitcoin consumes more energy, more electricity than 80 percent of our States and more than many entire countries.

Bitcoin is wasteful by design. But this sort of waste just isn't necessary. Bitcoin's guessing game system called proof-of-work is essentially crypto-currency version 1.0. But newer versions accomplish the same thing faster and cheaper. Ethereum, for example, recently converted to a newer proof-of-stake system, and it can do everything Bitcoin can do and more while using just a fraction of the energy.

For now, though, Bitcoin's system is still dominant. The enormous amount of energy it wastes must come from somewhere. In Pennsylvania, we are seeing that on the ground.

In 2021, one company announced plans to purchase three waste coal-fired power plants, and install up to 57,000 miners. They already have two of these plants in operation. Waste coal is a problematic fuel to say the least. As the name implies, it has low energy value compared to ordinary coal, so plants need to burn even more to generate the same amount of electricity.

In the process, they emit more ozone precursors, fine particulates, acid gases, heavy metals, and it is the second most carbon-intensive generation next to residual fuel oil.

Just in January of last year, State inspectors found 10 megawatts worth of generation have literally been plugged into fracked gas wellheads, and they were using the gas to mine Bitcoin without obtaining any permits. This sort of mining is increasing, but without clear reporting requirements, it is impossible to know which or how many of Pennsylvania's thousands of fracked gas wells are being used in this way. Media reports and even permit applications are sporadic, and even where there are reports, miners may call themselves data centers and not mention Bitcoin at all.

In addition to the problem from drilling and fracking, Bitcoin mining also causes noise pollution. The sound of these operations has been compared to the whine of a giant dentist's drill or a jet engine that never stops. In some cases, it can be heard for over a mile away. More than just an annoying nuisance that lowers property values, persistent noise pollution has been shown to cause health problems for both people and wildlife.

And it is not just burning fossil fuels directly that is the problem. In Pennsylvania, we are seeing Bitcoin operations at nuclear power plants. The operators claim this is carbon-

free energy, but that doesn't tell the whole story. We don't have a surplus of clean carbon-free energy on our grid. So when carbon-free energy is diverted from powering our grid to wasteful cryptocurrency, something has to make up the difference, and that is often fossil fuels.

Bitcoin mining is bad for public health and the environment. It is bad for the power grid and our wallets as well. Miners claim that they can easily pause operations when the grid needs power, but that only happens when the electricity is worth more than the Bitcoins. Essentially, we are linking our electricity prices to the volatility of the Bitcoin market, and that is a terrible idea.

Worse yet, by wasting the cheap electricity on Bitcoin mining, wholesale prices go up for everybody else. In short, Bitcoin mining is wasteful by design, and waste is never good. Thank you.

[The prepared statement of Mr. Altenburg follows:]

Senator Markey. Thank you, Mr. Altenburg.

Dr. Kelles, you are up.

STATEMENT OF THE HONORABLE ANNA R. KELLES, PH.D., ASSEMBLY MEMBER, NEW YORK STATE ASSEMBLY, 125TH DISTRICT

Ms. Kelles. So wonderful to be here today, thank you.

I would like to voice my support for Senator Markey's Crypto-Asset Environmental Transparency Act as the representative of the 125th New York Assembly District.

The environmental and socioeconomic impacts of expanding proof-of-work based crypto-currency mining will continue to have devastating environmental and socioeconomic consequences. It is estimated that cryptocurrency mining facilities for the proof-of-work based currency, Bitcoin, used more energy than all the processing for Google, Amazon, and Facebook combined, more than all the data centers globally combined, and more energy than all the solar panels that exist globally.

In fact, according to Digiconomist, one Bitcoin transaction requires approximately 860 kilowatt hours. This is equal to the energy needed to power the average U.S. household for one month. Given that a cryptocurrency mining operation creates minimal jobs, for example, a large U.S. operation of 100,000 ASIC processors employs 40 staff per shift, yet a year ago made $2 million per day. Profits for a cryptocurrency mining company are thus limited not by labor costs, but rather by the cost of electricity.

As one of the solutions for cheap energy, cryptocurrency

mining companies work to reopen retired fossil fuel power plants like the large-scale facility called Greenidge, in Dresden, New York, on Seneca lake. An environment with moderate temperatures, clean air, and abundant fresh free water for cooling have made New York an ideal location for cryptocurrency mining companies.

In the Finger Lakes, Greenidge provides service directly to the cryptocurrency mining operation on their property, maximizing their State permit-allowed GHG emissions and increasing local air pollution, including nitrogen oxide and sulfur dioxide. Due to the frequent replacement of cryptocurrency mining processors, the facility has also created a notable amount of electronic waste.

Facilities like Greenidge also negatively impact aquatic life due to the large quantities of water withdrawn from freshwater bodies to cool the electrical generation systems and the large-scale computer processor rings. Water is removed at temperatures of 40 to 50 degrees and released back at temperatures of up to 108 degrees, killing thousands of fish every year, and increasing the risk of harmful algal bloom outbreaks that are toxic for both wildlife and humans.

Gas-fueled power plants also affect the health and quality of life in surrounding neighborhoods. Emission of hazardous air pollutants are known to cause asthma, heart attacks, strokes,

reproductive damage and preterm birth. These public health impacts are most acutely felt in environmental justice communities.

Noise pollution is another significant concern for residents in towns across the Country who have stacks of consolidated mining rigs in open fields or mining warehouses in their community. The long waves of low-frequency noise ravel for miles around the cryptocurrency mining facility and are often characterized as sounding like jet engines.

In addition, according to a Berkeley Haas working paper, the power demands of cryptocurrency mining operations in upstate New York push up annual electric bills by about $165 million for small businesses, and $79 million for individuals, with little or no local economic benefit.

Although communities hosting cryptocurrency mining facilities experience few economic benefits due to minimal job creation and profits going to non-local corporate investors, these facilities can threaten other critical industries. In the Finger Lakes, for example, the $3 billion annual tourism industry that employs over 65,000 people and relies on the lakes and the natural environment is directly threatened by the polluting activity of Greenidge.

With respect to meet our climate goals, large scale cryptocurrency mining in New York State is significantly

increasing the State's total base energy demand on the grid, putting further pressure on our need for a massive electrical line overhaul. Due to the overall increase in base demand, some estimates suggest we need to increase our wind and solar infrastructure development goals by over 60 percent to meet our State climate goals just with the existing in-development and proposed cryptocurrency mining operations in New York.

Other forms of validation, such as proof-of-state, utilize far less energy. For example, Ethereum recently transited to proof-of-state, resulting in a total immediate energy consumption reduction of over 99.9 percent.

Please pass the Crypto-Asset Environmental Transparency Act. We must carefully study the environmental and grid impacts of cryptocurrency mining methods, such as proof-of-work mining, and implement appropriate statutes and regulations to prevent the damage it is doing and will continue to do to our public health and environment.

Thank you.

[The prepared statement of Ms. Kelles follows:]

Senator Markey. Thank you so much.

Courtney Dentlinger, whenever you are comfortable, please begin.

STATEMENT OF COURTNEY DENTLINGER, VICE PRESIDENT, CUSTOMER SERVICE AND EXTERNAL AFFAIRS AND CHIEF CUSTOMER OFFICER, NEBRASKA PUBLIC POWER DISTRICT

Ms. Dentlinger. Thank you. Good afternoon, Chairman Markey, and Ranking Member Ricketts. Thank you for the opportunity to testify today.

I would like to share a little bit about Nebraska Public Power District, or as I will refer to it, NPPD, and the territory we serve, to set the stage for my remarks regarding our experience with cryptocurrency mining. As Senator Ricketts mentioned, Nebraska's electric utility industry is unique and the legacy of Senator George Norris. We are the only 100 percent public power State in the Nation.

NPPD is a public corporation, and a political subdivision of the State. We are not-for-profit. Our rates are set to deliver reliable, affordable, sustainable energy and related services to our customers. We do not have shareholders; rather our customers are in essence our owners. Our approximately 2,000 employees operate our integrated electric utility system, including generation, transmission, and distribution facilities. Our chartered territory encompasses all or parts of 84 of the State's 93 counties, spanning 500 miles from east to west.

The majority of our service territory is rural. The largest city we serve has fewer than 35,000 people. Much of the

area receiving our power supply is farm and ranch land where crops and livestock are grown to help feed America and the world, along with significant ag processing, and other manufacturing. Our 3,200 megawatts of diverse generation located across the State includes nuclear, coal, gas, wind, hydro and solar. This diverse generation mix helps us meet our customer expectations to be reliable, affordable, sustainable and resilient.

NPPD and our fellow Nebraska utilities are proud to offer some of the lowest rates and highest reliability among the 50 States. We serve our Nebraska customers with a resource mix that is 62 percent carbon-free. In 2021, our board set a goal of achieving net-zero carbon emissions by 2050, while emphasizing the need to maintain reliability and affordability.

In fact, we are actively pursuing multiple technologies as we look to the future of carbon-free energy. NPPD is leading Nebraska's efforts along with partners in Iowa and Missouri to pursue Federal hydrogen hub designation. We are currently conducting a feasibility study to determine potential locations for advanced nuclear reactors. And we are working with the U.S. Department of Energy and several companies on carbon capture and sequestration opportunities.

In Nebraska, like most other States, electric utilities, regardless of type, have exclusive retail service areas, which

include an obligation to serve all customers under just, fair, and reasonable rates. We cannot refuse customer based on the business they may offer. We generally must serve all electric loads agreeing to meet applicable terms of service.

Just as every generation source has its benefits and challenges, so does each type of customer load. Historically, steady electric demand from a customer resulted in the most efficient use of electric infrastructure at a lower cost per unit of electricity for those customers. Today, the variability of generation from an increasing amount of renewables, as well as other considerations, is allowing for opportunities for new tools to be implemented to manage generation and loads, including innovative rate designs and demand response.

In our predominantly non-metro and rural service areas, diversification of businesses and economic growth is critical as these areas continue to see population declines. In fact, local leaders have been very receptive to crypto-mining facilities as they have seen the potential for significant economic development benefits for their communities.

An economic impact study performed for a crypto mining project in Nebraska showed over a $65 million economic impact on Nebraska's economy, nearly 200 associated and direct and indirect jobs, and $5.59 million in tax revenue. In rural areas, these economic benefits can be significant.

The projects we have seen have an average wage of $60,000 per job, higher than our median household income. Unlike traditional hyperscale data centers, which often need to locate in metro areas for workforce and redundant fiber needs, these types of crypto operations are more suited for rural areas because of smaller workforce requirements, less stringer redundant fiber requirements. Although the number of jobs is smaller, again, these good-paying opportunities can have significant impact in a rural area.

These types of projects can also be more flexible with respect to siting and often seek locations where there is existing excess or unused transmission capacity. They also have very high capacity load factors, running nearly 24 hours a day, 7 days a week, which is actually a benefit for load-serving entities. The load can be very flexible. They often seek interruptible rates and can quickly drop loads, which has proven to be helpful during local storm damage related events and even large-scale grid events, where transmission or generation might be insufficient to serve load.

With that, again, I appreciate the opportunity to share our experience with you today. I look forward to any questions you may have.

[The prepared statement of Ms. Dentlinger follows:]

Senator Markey. Thank you so much.

Now we will turn to a round of questions from the Senators. As we work to decarbonize our economy, we have to demystify electricity guzzling industries like Bitcoin mining. Bitcoin has an outsized effect on our grid and on our climate. Why is that? Well, because Bitcoin mining is inherently energy inefficient. The more demand there is for Bitcoin, the more work it takes to generate new Bitcoin.

I operated an ice cream truck to pay my way through college. So it is like saying that if my truck got worse gas mileage, it would be because each new ice cream which I sold reduced the energy efficiency of the truck.

Mr. Altenburg, is it true that Bitcoin's proof-of-work mining mechanism is set up to require more energy to earn each new Bitcoin as more miners come into the market?

Mr. Altenburg. Yes, it does. That occurs in two different ways. One is the Bitcoin race, the difficulty level of mining a new block gets harder the more miners mine. That is on the short time scale. We also have the issue on a longer-time scale where every approximately four years, the amount of Bitcoin that you get from mining is cut in half.

Senator Markey. So Bitcoin mining is like a fuel economy regulation in reverse. As time goes on and computers get faster, the network automatically adjusts to make sure more

energy gets used. Mr. Altenburg, even if we improve the energy efficiency of crypto mining computers, would that lead to lower energy usage?

Mr. Altenburg. Bitcoin mining is inherently wasteful by design. The miners already have incentive to make the mining hardware as efficient as they possibly can, because of the enormous amount of energy they have to use. The problem is, as efficient as they can possibly be, they are not efficient enough. They are always going to increase the energy demand.

Senator Markey. So Bitcoin uses as much electricity as we need to power every light in every home in the United States on a daily basis. Globally, if Bitcoin mining was a country, it would be in the top 30 countries based on energy use worldwide above countries like Norway and Sweden.

Mr. Altenburg, Bitcoin supporters predict that the Bitcoin price will increase dramatically in the coming years. Does that mean that the electricity demand from Bitcoin mining will also increase?

Mr. Altenburg. As more miners enter the fray, enter the mining competition, we do see an increase, we have seen that. When Bitcoin was worth $60,000 a Bitcoin, we had more active mining than we do at today's prices.

So yes, it is going to continually get more difficult to mine Bitcoin and the amount Bitcoin miners are going to be

rewarded with is going to continue to get less and less. This system will continue to spiral at an exponential rate, using more and more energy.

Senator Markey. Thank you.

Dr. Kelles, was uncontrolled energy use a factor of concern in your assessment of Bitcoin mining in New York State?

Ms. Kelles. Yes, absolutely. Particularly given the impact on one, our climate goals, and two, our energy grid. We have very aggressive climate goals. The concern was that amount of cryptocurrency mining that was growing rapidly in New York State would actually derail our ability to reach our climate goals.

Particularly, the more renewable energy infrastructure we put in place, if we divert that to the cryptocurrency mining, there is a profound opportunity cost that that exactly same renewable energy infrastructure would not be available then for all of the existing building infrastructure and transportation infrastructure, which are two of the biggest contributors to greenhouse gas emissions that we want to get on onto the electric grid.

Senator Markey. Thank you, Dr. Kelles, very much.

So, at this juncture, there is a roll call on the Floor of the Senate right now, and I will leave it up to Senator Ricketts, my thought would be that I would hand the gavel over

to him, I am going to run over and make the roll call and try to get back here. It will be a relay race; then he can run over and make the roll call as well. So let me turn it over to Senator Ricketts.

Senator Ricketts. [Presiding.] Thank you, Chairman.

Ms. Dentlinger, we were talking a little bit earlier, and you have first-hand knowledge of the economic development that we are talking about, the jobs that are created, the investment, the tax revenues and so forth that we get from investments in our State. Nebraska Public Power is no stranger to the crypto industry. What benefits in terms of economic development have you seen from new businesses in the crypto energy who are locating to Nebraska? Can you expand upon some of the things you were talking about before, please?

Ms. Dentlinger. Thank you, Senator. Absolutely. We have actually seen significant benefits from this industry to date, mostly farm tax revenues and then job creation. Again, those are very good-paying jobs, particularly in rural areas of Nebraska. The tax revenues for the State and local political subdivisions, we have seen just for one crypto mining facility in Nebraska $1.6 million in State sales tax over a 12-month period. During that same time frame, $3.8 million for the local taxing authorities.

That enables infrastructure investments in the host

communities. In fact, due to those increased tax revenues, that Nebraska community has been able to make significant enhancements to its regional municipal airport, to attract commercial air service to the community, which is important not only from a quality of life perspective for the residents there, but also for recruiting additional economic development prospects to the area.

Senator Ricketts. Is it also fair to say that it also helps to keep property taxes down?

Ms. Dentlinger. Absolutely. That is certainly a concern in the State of Nebraska. Those sales tax revenues help every resident at the State on their property tax bill.

Senator Ricketts. Are you hearing from companies that want to locate their crypto industry in the State of Nebraska, who have expressed an interest in moving?

Ms. Dentlinger. We certainly are. There is a great deal of interest, due in large part, as you mentioned, to the low rates that we have, but also to the rate designs that we have put in place. Our customers, both rural public power districts and municipalities, are eager to host these opportunities, again, because of the tax benefits and the good-paying jobs that they bring.

Nebraska is also rather unique because we have historically had additional capacity available. We are the Country's largest

irrigator, thanks to the Ogallala Aquifer. And many irrigation wells have been converted to electric from diesel, because the load, while large, is seasonal. So two to three months out of the year, during the summer, those irrigation wells demand a lot of electricity. But the remainder of the year, we have additional capacity to spare.

Senator Rickets. Great. One of the things that has been mentioned here today is the impact of these facilities on emissions, the crypto assets mining businesses are responsible for increasing fossil fuel use and driving up greenhouse gas emissions. Ms. Dentlinger, my understanding is that Nebraska Public Power District is leading the way in the development and deployment of new clean energy technology, such as supporting a regional hydrogen hub, you mentioned that in your opening remarks, and supporting deployment of carbon capture technology, which you also mentioned.

Can you tell us a little bit more about the role new industries play in supporting clean energy technology and adoption in Nebraska?

Ms. Dentlinger. Yes. Load growth creates opportunities. As you mentioned, we are exploring a number of those currently. We are in the process of developing our integrated resource plan. New load means an opportunity for additional generation resources and clean energy technologies would be part of those

additions. In fact, any new generation resources we deploy would have a lower carbon footprint.

Loads with higher load factors, such as crypto mining, which means they are utilizing electricity at steady rates rather than ramping up and down, can produce more constant revenue streams, which in turn can help finance those clean energy technology deployments.

Senator Ricketts. So to kind of just typify this a little bit for me, is it fair to say that if you and your community have a crypto currency or crypto asset generating facility that is creating more demand for electricity, and because of the scales of utility generation, you can actually help reduce the utility bills for other customers? Is that fair?

Ms. Dentlinger. So, we work very hard to make sure that we are not shifting costs among various types of customer classes. We certainly are not subsidizing crypto. But because those mining operations again are so stable in the usage of electricity it actually helps systemically for those costs that we do socialize to bring the costs down for every user.

Senator Ricketts. Yes, so because you have to give that consistent demand, you can keep it relatively, other people's rates, relatively lower, is that fair?

Ms. Dentlinger. Yes. Consistent usage, 24-7, can actually be the most efficient use of electric infrastructure.

Senator Ricketts. All right, great. Thank you.

Mr. Carper.

Senator Carper. Mr. Chairman. Been in the Senate less than three months, he is already chairing committees.

[Laughter.]

Senator Carper. Thank you for letting me work into the lineup.

I want to start off by thanking Senator Markey, our Chair, for today's hearing on his legislation that seeks to shine a light on the impacts of cryptocurrency on our environment. I held the first oversight hearing in Congress on cryptocurrency almost 10 years ago on November 18th, 2013, when I was privileged to be Chairman of the Homeland Security and Governmental Affairs Committee. Today, we are here having the first hearing in the Senate that is focused on the environmental impacts of cryptocurrency.

Regardless of what they believe about the role of cryptocurrency in the global economy, I hope we can all agree that cryptocurrency shouldn't be increasing pollution that affects the air we breathe and the water we drink, or that otherwise degrades our climate and our environment.

Today we know that some cryptocurrencies require a massive amount of energy to power and control the temperature literally of thousands of computers, which run, I am told, all day and all

night. I am told that cryptocurrency currently uses up to 1.4 percent of our Nation's electricity, 1.4 percent of our Nation's electricity. That is as much electricity as is needed to light every home in this Country.

When I first saw that, I had to read it twice. That is as much electricity as is needed to light every home in this Country.

As many industries are looking to reduce their energy usage, we have heard today that cryptocurrency electricity usage is surging as the need for additional computing power grows. We have also heard today that there is a lack of data on where and how this power is being generated.

I am going to start with a question for Mr. Altenburg. First of you, then Ms. Kelles. Are there ways for cryptocurrency to have fewer environmental impacts and still allow communities to benefit from the economic engine that it can provide?

Mr. Altenburg. Certainly, Senator. Our main concern is about proof-of-work cryptocurrency, which is the system that Bitcoin uses. This system is wasteful by design. Part of the mechanism for generating new Bitcoin requires using enormous amounts of energy.

The number two cryptocurrency by market cap in the Nation right now, Ethereum, uses just a tiny, tiny fraction of that.

There are literally dozens of competing technologies that can accomplish everything Bitcoin can do and more, without using that enormous amount of electricity.

Senator Carper. Say again the approach that uses so much less electricity? Say it again.

Mr. Altenburg. Could you repeat the question?

Senator Carper. Yes. You just said that there was an alternative that uses a lot less electricity to create. What was it?

Mr. Altenburg. Ethereum is a competing cryptocurrency. It uses a system call proof-of-stake. That is a class of systems that can reduce energy while still maintaining blockchain technology and cryptocurrency.

Senator Carper. Thank you.

If I could, Ms. Kelles, same question. Are there ways for cryptocurrency to have fewer environmental impacts and still not reduce the benefit from the economic engine that it can provide?

Ms. Kelles. Absolutely. I wanted to note with respect to Bitcoin first, Bitcoin is one of the most consolidated cryptocurrencies on the planet. Point zero one of the accounts own about 27 percent of the currency. So to say that this is a currency accessible to all people is misinformation.

What was previously mentioned, proof-of-stake, is another form of validating. There are about 16 different kinds of

validations of cryptocurrencies. Proof-of-stake is the second most common. That is what Ethereum is built on. Ethereum also proved that you can convert, you can change from proof-of-work to proof-of-stake, sort of in the middle of flying the plane, when the blockchain is already active.

So it is possible for ones who are using proof-of-work to shift over and reduce their total energy consumption by over 99 percent.

The thing that is also really important is that proof-of-stake is in many ways more nimble. It is really the validation system where a lot of smart contracts are used, where there is a lot of the innovations and decentralized finance Web3 systems. So I would actually say that proof-of-stake is where we can see a lot of, expect a lot of the innovation to happen, and not on more dinosaur proof-of-work based validation methods.

Senator Carper. Thanks very much for that.

I am going to come back to you, Mr. Altenburg. What types of data or further research is needed to better understand to monitor and to mitigate the energy and climate impacts of cryptocurrencies?

Mr. Altenburg. Thank you, Senator. One of the big problems we are seeing right now, particularly in Pennsylvania, is a lack of knowledge. We have asked even regulators where all the crypto mines are, and they really can't say with any degree

of certainty. We have had a situation that happened in January of 2021, where inspectors from the State's department of environmental protection showed up at a fracked gas well and found Bitcoin mining hardware plugged in. Nobody applied for permits, nobody notified anybody. These operations can just start up overnight.

That is why the reporting requirement of the Crypto-Asset Transparency Act is particularly important, so we will have some ability to see where these facilities come into communities. Sometimes when they come into the communities, they say they are a data center, they don't even mention crypto mining. So even the community has no idea what is going on next door.

Senator Carper. I am a United States Senator, but I have been a recovering governor for 22 years. As a former governor, I love to learn what works well at the State level and do more of what works well, find out what works and do more of that. States and governors are pretty good at that when it comes to addressing difficult problems.

What are some of the lessons learned from your experiences addressing pollution from cryptocurrencies in New York that may not have been mentioned yet in this hearing?

Ms. Kelles. I would elaborate on one, two that have been mentioned but haven't really been extensively discussed, which is, one, the impact on water quality. We have a facility that

started the conversation here, and I mentioned it in my testimony, Greenidge. They pull up to 140 million gallons of water a day from a lake and use that to cool the facility, then release it back into a Class C trout stream. Trout show signs of stress and start to die out at over 70 degrees temperature, and the water released is up to 108 degrees temperature.

So it is seriously affecting the ecosystem, and also affecting all the livelihoods around that area, including fishing, hunting, the agrotourism industry, as I mentioned, which we have the Napa Vallely of the east. The wine industry here is really important. Not only does the facility affect the water quality, but it also affects the experience because of profound noise pollution.

The other thing we haven't talked about as much, and I think it is really important, is the opportunity cost of investing significantly in cryptocurrency mining operations. We have huge amounts of greenhouse gases as a State, as I said earlier, from our buildings, and from our transportation and other aspects of our industry, of our State economy. It is going to be a significant challenge to get all those onto electrification. The more cryptocurrency mining we have in the State that is feeding directly off the grid, the harder it will be to get all of those onto the grid because of the strain we experience.

I will say one last thing, which is, I hear often from the proponents that cryptocurrency mining can act as a battery. That is simply not true. It doesn't produce any energy, it doesn't store any excess energy. It can shut off when there is high demand, but in most cases that I have read of, in fact it actually has a contract, like in Texas, where it gets paid to shut off. In fact, Texas makes, in some cases, cases that I have read, more money when they shut off than when they do run their facility.

So I would not say that that is a cost-free battery storage system in place. It is an opportunity cost, and we really should be focusing on investing in the renewable energy infrastructure and long-term storage to create a long-term renewable energy infrastructure for our State.

Senator Carper. Thank you very much. Mr. Chairman, let me say thank you for bringing this together, and bringing our witnesses to consider this issue. Frankly, it is not something as we are going through the battle, the fight on climate change and crafting legislation, whether it is the climate provisions in the Bipartisan Infrastructure Bill, whether it is the work we did in the Inflation Reduction Act, it's not something that I think many of us have thought about. Thank you for bringing it to us. And thanks to our witnesses for joining us today.

Senator Markey. [Presiding.] Thank you, Mr. Chairman,

very much.

A lot of this just fits into the frame of energy efficiency. My mother would always say, your father and I are going to donate your brain to Harvard Medical School as a completely unused human organ. She would say, you have to learn how to work smarter and not harder. I would be 10, 11, 12, she would just keep saying the same thing.

So when I authored the appliance efficiency laws in 1987, for example, the air conditioning is 80 percent of peak demand in Texas in the summer. If they doubled the efficiency, it would be half the electricity that people would have to purchase. And they fought it, but once the law passed, they did it. The same thing was true for refrigerators, for stoves. They figured it out.

Same thing was true for automobiles. I used to make the amendment every year on the House Floor to increase economy. The auto industry said, you just don't know how hard it is. So we finally, in 2007, we passed my bill. And then Elon Musk just went to the markets and said, hey, I will be able to meet the standard. Give me money for all-electric vehicles.

So that is what we are talking about here. We are just talking about, in my mother's words, working smarter and not harder and getting the same results.

Senator Carper. Could I just say, I think our parents were

talking with each other, even back then.

Senator Markey. You know, a correct assessment of our untapped human potential, I agree with you. I am sure it is a miracle that we are here from their perspective, given our attitudes at age 10.

[Laughter.]

Senator Markey. So the Bitcoin network uses a mechanism called proof-of-work to issue new Bitcoins to miners. The problem is in the name itself, you need to prove you have done a lot of work and used a lot of energy in order to get awarded any Bitcoin. We can't be fooled into thinking that this amount of energy must be used in order to participate in crypto-asset markets. Other assets, like Ethereum, use methods that cut energy use by 99.9 percent.

Mr. Altenburg, could Bitcoin change its code to save substantial amounts of energy?

Mr. Altenburg. Ethereum certainly did that, switch from proof-of-work to proof-of-stake. Whether or not Bitcoin itself can arrange to do that, that would remain to be seen. But it is certainly possible.

Senator Markey. It is possible. So if it is possible, and it is more energy efficient, and it gets the same result, they could move in that direction and still achieve their economic goals.

So this isn't an issue that is built into blockchains. It is an issue that has been into Bitcoin, which is the difference. It all depends upon how that company or industry approaches the issue of energy efficiency. All power plants are held to the same emissions standards; all trucks are held to the same emissions standards. But crypto assets don't have those across-the-board standards. Some like Bitcoin get away with damage that the others would never dream of.

That has to be the goal, because we know that Bitcoin mining will also increase if they have more energy efficiency standards which they use. In our opinion, does a higher Bitcoin price mean more incentive for Bitcoin miners to use more energy? You do agree with that?

Mr. Altenburg. We have seen that in practice.

Senator Markey. You have seen that in practice. So we just have to recognize that, and then take the analogous situation with refrigerators, stoves, air conditioning, automobiles, and just say that we are not looking to end refrigeration or automotive technology, we are just saying that we should be more efficient, we should be more aware of the emissions into our atmosphere that are avoidable.

So on the one hand, this is a very innovative sector economically. They tout themselves as innovators. All we are asking for them to do is look across the board at innovation,

not just that one idea, but embracing innovation and energy efficiency, innovation in the technologies which they use in order to generate their innovation.

That is why this hearing is so important, so that we can have a meeting of the minds over mining, so that we benefit from all of the lessons we have learned over the last 30 years that people thought were absolutely impossible to implement.

I thank you all again for the information. Let me turn again to Senator Ricketts.

Senator Ricketts. Thank you, Mr. Chairman.

Mr. Altenburg, you had mentioned a couple of things that you said were problems with Bitcoin generation or I think you were talking about Bitcoin in particular. You mentioned they were talking about bringing online three waste coal plants in Pennsylvania, is that right? Again, I am from Nebraska, I am not from Pennsylvania, I don't know all the rules.

But wouldn't each of those plants have to be permitted to be able to go into operation? To get those permits, wouldn't they have to comply with the overall emissions targets for the State of Pennsylvania?

Mr. Altenburg. There are two waste coal plants that are in operation. They were existing waste coal plants that were in operation and they were operating at very, very low-capacity factors. All these plants are heavily subsidized.

Pennsylvanians pay 60 percent of the energy cost for the Bitcoin miners of these plants through subsidies from taxpayers and ratepayers.

But yes, they do, the plants do meet their current permits, but they are increasing their emissions because of Bitcoin mining.

Senator Ricketts. Is there a real limit on what they would be able to generate as far as power because they are generating more emissions? Or do they have some sort of grandfather clause that allows them to just continue to generate?

Mr. Altenburg. The State established permit limits for them based on the fact they are 90-megawatt plants each. They were operating, again, at much lower capacity. So they weren't operating anywhere near that before Bitcoin mining started. Now they have ramped up their capacity.

So where they are, we believe operating under their permit limits, they are still emitting a lot more than they were just a few years ago.

Senator Ricketts. Okay. You also mentioned something about Bitcoin operators plugging into fracking gas wells, and that was illegal, is that my understanding? So there are laws against them doing that? Is that right? Without getting a permit, that is.

Mr. Altenburg. They plugged it in without a permit. The

Department of Environmental Protection issued a notice of violation in that case. But I believe there is still litigation in process over that.

Senator Ricketts. But essentially what you are saying is, it was illegal for them to do that in the first place, so they were breaking the laws anyway, right? Is that accurate?

Mr. Altenburg. I believe they were. But that has not been determined.

Senator Ricketts. Not been proved yet. Okay. You also mentioned the noise pollution as well. So help me again with Pennsylvania. Are there rules or permits? Don't you have to get a permit or something with regard to noise or generation for facilities?

Mr. Altenburg. Noise pollution is generally handled by local municipalities. It has traditionally been handled as a local nuisance issue. So one of the recent fracked gas wells that is going into operation, Bitcoin, is in the location of the State called the Pennsylvania Wilds, which is some of our most pristine habitat. Frankly, there aren't a lot of neighbors in that area to file noise pollution complaints. What we have is a considerable amount of wildlife that the tourism industry depends on. So this noise pollution could directly impact the tourist industry. But there really isn't a strong regulatory mechanism.

Senator Ricketts. But there would be a local entity, maybe a county or something like that, who could put limits on how much noise you could generate, is that accurate? There is some form of local government there to put in those.

Mr. Altenburg. There is local government. I don't know the extent of their authority towards noise pollution.

Senator Ricketts. Okay. Dr. Kelles, I think you also mentioned that noise pollution was one of the things, I think you described it as a jet engine, is that right?

Ms. Kelles. Correct.

Senator Ricketts. So, same question to you, isn't the local entities, like a county or a city that would put in ordinances or whatever to say, hey, you can only have so much noise allowed?

Ms. Kelles. Yes, and there actually has been some effort like my colleague mentioned. There are limits on how much they can prevent and permit. There have been, there is at least one example of a moratorium on cryptocurrency mining because of issues of noise and all the safety issues, health and safety issues. It was a temporary one. So they were able to do a temporary one there, yes.

Senator Ricketts. Ms. Dentlinger, we are running out of time here, so I will ask you to be brief. In your experience, NPPD, I know that some counties in Nebraska have ordinances with

regard to say, wind setbacks for noise, and so forth. Is that your experience in Nebraska as well?

Ms. Dentlinger. Yes, I speak from my previous economic development experience. Typically we would see zoning regulations both within municipalities and then within counties. And if they wanted to regulate decibels levels from any industry, as you mentioned, we have seen that recently with wind, they put those regulations in place.

Senator Ricketts. Great. Thank you.

Senator Markey. As I said in my opening remarks, this virtual commodity has real-world impact. We don't know the total scope of the environmental effects of crypto mining. The White House Office of Science and Technology has specifically called for more information but they don't have the authority to call for it, which is the why the Crypto-Asset Environmental Transparency Act is so important.

Mr. Altenburg, do you agree that this legislation would provide more transparency and disclosure which could help us to oversee and understand the environmental impacts of crypto mining? It is almost alone in the entire American economy, kind of sealed off from the knowledge, the information everyone should have about the environmental impacts of the industry.

Mr. Altenburg. In Pennsylvania, we have an environmental rights amendment to our constitution that guarantees the public,

actually the ownership of their public natural resources. One of the big things we are seeing with cryptocurrency and the lack of transparency is the public does not know where these facilities are coming in, they do not know where they are using the power. They do not know where the power is being used, they do not know where the pollution is.

As long as we have that, the State is not in a position where they are going to be able to effectively regulate these facilities.

Senator Markey. When I was growing up in Ward 2 in Malden, Malden is a city about four miles north of Boston, my grandfather got off the boat from Ireland, worked on the Malden River, and I grew up three blocks from there. My mother, when I was about 10, again, much more intelligent than I am, she would say, Eddie, whatever you do, don't swim in the Malden River. It was kind of black with a pre-Jimi Hendrix purple haze over it.

[Laughter.]

Senator Markey. All the industries used the Malden River as a dumping ground, the coal industry, every Converse All-Star was made in my home ward, 8,000 people just using the Malden River. So it was obviously an era where there really weren't a lot of regulations. There was kind of a black cloud over our neighborhood growing up.

On the other side of town, they didn't have a black cloud,

where other people lived. But in my home ward, it was kind of the working-class ward. Every city has a ward like that.

My goal here is just to provide transparency, the disclosure that could help us to see and understand environmental impacts of crypto mining. Dr. Kelles, is that an unreasonable thing to ask, that people just understand what the impacts are?

Ms. Kelles. Absolutely not an unreasonable thing to ask. We can't improve our environment if we don't know how it is being used and we don't know what is happening around us. A perfect example is, we are now aware of the coal piles that were being used for providing energy, the coal piles that are left over and sitting on the road bank edges in Pennsylvania.

Now because of the fact that that made it into the news, otherwise we would not have known, we are having an honest conversation about it. The proponents would say, it is better to burn it than let it sit there and have the pollutants like the mercury leak into the waterways.

But I would ask in that conversation, which is better, that it pollutes the water or pollutes the air? If we don't have transparency, we don't have disclosure, we can't have an honest conversation about that. Neither one of those pollutions are what we are looking for. Of course, burning it, then we end up with the ash. So that is another pollutant.

It is a great analogy, just like with coffee, running water over coffee grounds like the ash, we just farm more coffee, or in this case mercury, out than if you ran water over whole coffee beans, which is the actual unburned coal. So which one is worse?

Again, we can have that honest conversation but we can't, if don't have the disclosure and we don't have the transparency.

Senator Markey. So again, you make the case for more transparency because you can't manage what you don't measure. Unfortunately, we do know that harms are being felt now by families across the Country. I have received testimony from 12 States, from Georgia to Washington State, about the damage that crypto mining is already doing in their communities. I would ask unanimous consent that this testimony be included in the record.

Without objection, so ordered.

[The referenced information follows:]

Senator Markey. We are joined by Senator Lummis from Wyoming. Let's turn and recognize you, Senator, for a round of questions.

Senator Lummis. Thank you, Mr. Chairman.

My first question is for Mr. Altenburg. What does a digital asset mining operation look like? Are there shovels digging in the ground? What does it look like?

Mr. Altenburg. It depends on the location. The mining sites that are being placed at our fracked gas wells are essentially semi-trailers that have methane gas powered generators that are plugged into the well, and big shipping containers full of racks of Bitcoin miner.

Senator Lummis. And a Bitcoin miner is actually a computer?

Mr. Altenburg. It is about the size of a toaster, and it uses three times the energy of a house.

Senator Lummis. So there is a bunch of toasters in a line, sometimes they are dipped in fluids so they run cooler, they can be air-cooled, they can be water-cooled. But it is basically just a computer?

Mr. Altenburg. Yes.

Senator Lummis. Is that computer that is mining Bitcoin directly emitting pollutants?

Mr. Altenburg. No, its energy source, its electric source,

is what is emitting.

Senator Lummis. Okay. So now let's take an EV charging station. If that EV charging station is powered by electricity from natural gas or coal, shouldn't it also have the same monitoring that is being requested by this bill?

Mr. Altenburg. I think the issue is looking how efficiency is measured. All sources of electricity, whether it is the lights or the speaker system here, are going to use electricity and produce a certain amount of work for that electricity.

The issue with Bitcoin and proof-of-work cryptocurrency is the work that we are doing is not actually necessary to have cryptocurrency or to have blockchain technology.

Senator Lummis. Okay. Let's talk about gold. Where does gold come from?

Mr. Altenburg. It is mined.

Senator Lummis. It is mined, okay. Is energy expended in producing gold?

Mr. Altenburg. Yes.

Senator Lummis. Okay. Is gold absolutely essential?

Mr. Altenburg. For certain technologies, it is.

Senator Lummis. Is it Congress' job to decide whether an energy use is worthwhile or not? Surely you have heard that Bitcoin is digital gold, because it is limited to 21 million Bitcoin ever to be mined, it is permission-less, which means you

don't have to rely on a third party, a trusted third party to do transactions or to hold it. It is a store of value, and that is commonly agreed to.

So you have gold, it is a store of value, you have Bitcoin, it is a store of value. They both consume energy to produce.

Now, is it Congress' role to say gold is a more worthwhile use of energy than Bitcoin?

Mr. Altenburg. There is a long history of that very thing. We have energy efficiency standards for appliances, we have CAFE standards for vehicles. For most air pollution, for most new air pollution sources, there are legal requirements that before they operate, they install the best available technology to reduce the pollution.

So we do make those decisions every day.

Senator Lummis. So we are still mining coal in this Country. We are still producing natural gas, and we have the cleanest-burning natural gas in probably the world, here in the United States, and produce it in the most environmentally sound manner. But it is a hydrocarbon.

So if my car is oil-consuming or natural gas consuming, is it a less worthy use of energy than energy that comes from coal and natural gas but is converted to electricity for an EV?

Ms. Altenburg. Using vehicles, our entire transportation network requires a certain amount of energy. And there are

economic benefits that we get from that transportation network.

Senator Lummis. My time is about up, so thank you.

I have a question for Ms. Dentlinger. Do you view digital asset mining operations as a negative for the power sector?

Ms. Dentlinger. I certainly don't speak for the entire power sector. But within the State of Nebraska, we have actually seen benefits. We have not seen the drawbacks that have been mentioned during the hearing today. Most of those have just been managed locally, whether by the municipality, by the county, or by the Nebraska Department of Environment and Energy.

Senator Lummis. If you have a natural gas well and you are venting the natural gas because that well is not hooked up to a gathering line, is it better to vent it into the atmosphere, or is it better to use the energy to produce something of value?

Ms. Dentlinger. In my opinion, it is much better to actually use the energy and produce something of value.

Senator Lummis. Thank you. Mr. Chairman, I yield back.

Senator Markey. Thank you so much.

Air pollution is a major area of concern around crypto mining, as miners are bringing coal and gas fired plants back online, or even using dirtier sources of energy, like waste coal in order to buy power for their mining rigs. Mr. Altenburg, have you seen instances where crypto miners have kept dirty and

inefficient power plants online?

Mr. Altenburg. It certainly appears they have, especially in the two waste coal power plants in Pennsylvania. Prior to Bitcoin mining operation, they were running at very, very low capacity factors.

Coal-fired power plants tend to run 60, 70, maybe 80 percent or more of the time. They tend to want to run full out at a very constant rate. These plants were running closer to 10 percent of the time. So when Bitcoin came into operation, part of the goal was to increase the output of these power plants.

Senator Markey. So the energy use of Bitcoin, especially if it brings carbon-intensive generation back onto the grid, could threaten our climate goals and supercharge climate change. We already know we are living through unprecedented climate chaos.

If Congress turns a blind eye to an energy-intensive energy like Bitcoin while it works to tackle climate impacts, it is like a plumber who tries to fix an overflowing bathtub while the faucet won't stop running. The problem won't go away, and the damage will just get worse if you don't deal with the potential dangers that are right in front of you.

Dr. Kelles, do you agree that crypto mining jeopardizes State and Federal climate commitments?

Ms. Kelles. Absolutely, to answer it in the context of

what you were just speaking about. In New York State, we have about 49 retired power plants. They are retired, because they are less efficient, they are all using older technologies, single cycle turbine technology, and cannot compete on the market with the more modern dual cycle turbine technology, for example. So they were mothballed.

The crypto currency mining industry is buying up power plants in New York State and turning them back on and running them up to their full greenhouse gas emissions allowable permits. That is a situation where we had these facilities that were at zero emissions, they were shut down because of inefficiency.

So even if they are converted, as one of them was from coal to natural gas, we still have a significant increase in greenhouse gas emissions from a facility net zero which is where we were. And of course, everyone knows at this point that methane is a stronger greenhouse gas than carbon dioxide. Although coal is less clean with respect to all the types of particulates that it releases into the air, with the gas-fired power plant, particularly with the single cycle turbine that is less efficient, we are of course having significant increases in methane that is released through the entire process of getting the gas to the facility and then of course from the facility.

So it is significantly, I believe, hurting our ability to

reach our climate goals. We see another facility that is working to come online, and we have all the others that are in our State.

So we are very worried. That is why New York State put a moratorium on any of these power plants being turned back on by large scale corporate crypto currency miners, so that we ourselves could do a full-scale investigation of the impact of crypto currency mining on our ability to reach our climate goals.

Senator Markey. Thank you. Industry figures claim that Bitcoin miners can burn flared or vented methane gas to power their mining operations. We know that we need to cut down on our methane emissions. That is why we passed an historic methane emission reduction program as part of the Inflation Reduction Act.

I am curious as to whether these claims hold water. Mr. Altenburg, do you believe there are better ways to deal with flared and vented methane than using it to power Bitcoin mining operations?

Mr. Altenburg. What we have seen with Bitcoin mining, the innovation we have seen has been innovation in ways to justify that wasting energy is good. Methane is particularly one of those situations.

If you have a situation where you have enough methane that

you can capture, that you are flaring, if you can capture it to run a Bitcoin mine, you might as well capture it and put it into the distribution pipeline and get useful work out of it. There is no need to waste the energy that we are wasting on Bitcoin.

Senator Markey. So if there are better ways to deal with methane, we should avoid fossil fuels in the first place. At the end of the day, we have direct reports of harms and significant projections of impacts in our society. So that is just why we need more transparency across the board.

That is why we are fighting for it today. We are not saying ban, we are not saying don't ban, we are saying, let's just know what is happening. Information will be helpful for everyone, no matter where they live. Just understand, like my mother did, just don't swim in the Malden River. She didn't have any evidence except for the black cloud over our home ward, which wasn't over the other seven wards in Malden. The EPA wasn't even created for 20 more years after I was a boy.

Obviously, you just can't be working off your gut. You need information.

So if the industry is confident in its positive contributions to the environment, they should welcome the transparency of the Crypto-Asset Environmental Transparency Act that would provide that information. Really only vampires are afraid of the sunshine. In the same way that so many devices

that we plug in at night now, we are all plugging in all these devices every night. They are almost vampires consuming all this electricity.

I had this big battle about 15, 18 years ago with the computer industry. They were of course God's gift, oh my goodness, don't ask us to do an more, didn't we do a great job in just providing you with all these laptops at home? Don't ask us to do anything else.

I just said to them, is there any way you could cut the electricity consumption for the home computer when it is just on overnight in default position, when you have your kids' pictures up all night? Can you just cut that electricity consumption overnight? Oh, you have no idea how difficult that is, oh my goodness, you are asking us to figure out something like that after we have given you the great gift of home computers?

Of course they figured it out. Why would we have 100 million devices unnecessarily consuming electricity when you can just put the fix in to make sure it is more efficient while getting the benefit of the new technological breakthrough.

But that is just kind of the default position of a new group of geniuses in their little industry, you can't actually call upon us to have any additional burdens when all we are saying is, like my mother, work smarter, not harder. Just use a more efficient way of doing it.

Let me again turn to Senator Ricketts for more questions.

Senator Ricketts. Thank you, Mr. Chairman.

Dr. Kelles, you had said that in New York, that the crypto industry was going to turn on 49 plants that had been retired, is that accurate?

Ms. Kelles. No, what I said is we have 49 power plants. The concern is that there was a trend beginning, we saw one purchased and turned back on, and another purchased in the permitting process and turned back on with the existing rigs that they have. We have 49 in the State.

The concern was if that trend continued without us evaluating the full impact on our ability to reach our climate goals with respect to GHG emissions, water impacts, and air quality impacts, that we might not reach our climate goals.

So the idea of course was that we needed to stop that particular trend. I want to be clear: this was a very narrow moratorium. It was specifically on the purchasing of retired power plants in the State by consolidated crypto currency mining corporations. Of course, you and I probably can't afford on our own to buy a retired power plant. But this did not pertain to those that plugged into the grid or those using renewable energy infrastructure onsite.

So it was narrow, but the intention was to give us the opportunity in time to not have the full extent of the impact,

which I think is fundamentally parallel to what you are trying to do with this piece of legislation, to capture the data and be able to do a full analysis.

Senator Ricketts. Presumably, the other plants went through a permitting process, is that accurate? At least the one plant that did get up and running went through a permitting process and got permitted, so that was in operation, is that accurate?

Ms. Kelles. The first use, the permits that had been in place, and they got an extension of those permits, but then they went through a renewal process this last year and actually were denied an extension of that, the air permit, because it was recognized that the permit and the activity that was being used for that facility no longer aligned with our Climate Leadership and Community Protection Act. That is currently in the courts, because that was appealed. That will go through, I presume, for potentially even years. But that was the initial process.

The water permit was extended at the time. Actually for four years they were out of compliance with the permit that required that they put a screen up on the pipe that was pulling water into, from the lake, and then into the facility. Therefore, because there wasn't a screen, it was killing wildlife, a significant amount of wildlife.

Last year, they did finally put that screen in and are now

compliant. They were given a couple extra months to become complaint.

So that is with the water permit. We will see what happens with the renewal of that permit.

Senator Ricketts. So it is safe to say though, there is a process in place for the permits, and they go through the process, and the State itself was deciding whether or not to give those permits, is that right? You just said that the State denied them on the air permit.

So there is a way in place to be able to address the emissions, correct?

Ms. Kelles. Not fully. Those are only the facilities that are in power plants. But as we have talked about, there are many different types of facilities, so they can be mini-rigs inside shipping containers in a field, which is very common. They can be in a warehouse, all of those plugged into the grid. They can be plugged into the grid but doing net metering so paying for hydroelectric. Then there is the question of opportunity costs.

So the reason for the requirement for the full environmental impact assessment --

[Simultaneous conversations.]

Senator Ricketts. Everything that is going to provide power to any of these crypto things is going to have to be

permitted, right?

Ms. Kelles. No, not necessarily. You are pulling directly from the grid and you have a warehouse on your property, even if you have a different type of business, that does not require a permit.

[Simultaneous conversations.]

Senator Ricketts. The power that is generated to go into that warehouse has to be permitted, right?

Ms. Kelles. Not necessarily, no.

[Simultaneous conversations.]

Ms. Kelles. If you say there is no power generation, then there is no power generation. So if you are plugged directly into the grid, you are not producing your own energy.

Senator Ricketts. But somebody is producing the energy if it is supplying it, right?

Ms. Kelles. The grid. Yes. So it may be buying the energy from the grid, that is just the grid. If they want to pay more of an electricity bill, they will.

Senator Ricketts. Somebody has to put power into that grid, which means it has to be permitted some place, right?

Ms. Kelles. What is permitted would be the hydroelectric or any of the electrical generating facilities, but not a warehouse that is tied onto the grid.

Senator Ricketts. Dr. Kelles, I think you are missing my

point, that anything that is going to generate power, that is going to create emissions, is going to be permitted. There is a rule and system in place to be able to handle that, and you yourself have demonstrated in New York that you are taking steps to limit emissions based upon what you want to do in New York. And in fact putting a moratorium on bringing on any of these other lines.

So you are actually --

Ms. Kelles. I am being very clear, with all due respect, being very clear, there is energy generation and there is energy usage. Energy generation is regulated. Energy usage, if you have a restaurant or a warehouse, or if you have a superstore, you are not permitted for your energy usage. Usage is not the same as generation.

But generation, a generator is permitted. If you are not a generator, then you are not permitted in that way.

Senator Ricketts. Right, and that was my point, that all this power generation, not the use, the power generation is permitted, and New York is taking steps to do it.

Ms. Kelles. The question is whether or not there is an opportunity cost, because the energy that is used, the significant amount of energy that is used, when we are trying to get our entire grid onto renewable energy infrastructure, if we are increasing our baseload on that grid significantly, then we

will have to increase significantly our renewable energy infrastructure construction goals. The question is whether or not we have the land infrastructure and other ability to reach those goals. We have limited amount of land that we can build solar on, for example, and it competes directly with agricultural land and food production.

So there are limits.

Senator Ricketts. So, is Nebraska New York? And vice versa, is New York Nebraska?

Ms. Kelles. No, it is not.

Senator Ricketts. So they are different States. So it is fair to say that different States are going to have different needs with regard to power generation and permitting and clean air and things like that?

Ms. Kelles. Yes, and I would say with a caveat that any increased energy demands that you are putting on a grid means that you will need to produce more renewable energy infrastructure to make that grid completely renewable.

Senator Ricketts. Thank you, Dr. Kelles. I have run way over. Thank you, Mr. Chairman.

Senator Markey. Absolutely no problem. I love this subject. Honestly, every question we are asking is vastly expanding the body of knowledge for all the Senators. This is the frontier in terms of issues. It gets kind of arcane until

you have the discussion, then you can keep reducing it down to a more simple understanding of what we are talking about.

I love any question that anyone has, because I am learning from all of this as well.

Mr. Altenburg, do you think crypto supports or undermines our national goal for clean, affordable and reliable electricity?

Mr. Altenburg. It certainly does, even in the situation where we have crypto mining coming from our new plants, that is diverting carbon-free energy from the grid. We heard testimony or you have heard people say that doing things like using more Bitcoin mining can incentivize solar or bring more solar on the grid.

But that is not what we are seeing happening on the ground. The Bitcoin miners are incentivized to use energy sources that are available at very, very high capacity factors. In almost all cases, those are fossil fuel or formerly baseload resources. Those resources we have to, if we are going to decarbonize our grid, we are going to need clean, renewable generation. Wasting energy on unnecessary proof-of-work mining, when we can have crypto currency and blockchain technology without that is just counterproductive.

Senator Markey. Do you think that more disclosure would stifle or actually encourage innovation in this industry?

Mr. Altenburg. More disclosure always helps regulators. I speak from working for 22 years as a State regulator. Having the information to back up our decisions is absolutely essential.

Senator Markey. I just have a couple more questions. Do you have any additional, Senator? You do, great.

It is the goal of the legislation to provide transparency in all types of environmental impacts. People who live near crypto mining facilities have said "It is like living on top of Niagara Falls, it is like a jet that never leaves."

Dr. Kelles, is it true that crypto mining facilities produce non-stop noise which can affect quality of life, especially in rural communities?

Ms. Kelles. Yes, absolutely. That is what I hear also from constituents around the State, that it has not only significantly impacted their own experience, because many of them are in fields, many of them are in places where there aren't that many people. We have examples of a large-scale crypto currency mining operation near trails, and it is significantly impacting people's ability to appreciate nature and get away, because it is like standing on a tarmac, is what I have heard from people.

There is also some disturbing data on the impact of the noise on animal species, birds, which I think is actually

particularly disturbing given the estimates of decline in birds that we are already seeing.

Senator Markey. Could you also talk about the facilities using water in excess of necessary quantities?

Ms. Kelles. Yes. The facility that began this conversation, as I spoke of earlier, Greenidge, does pull in up to 140 million gallons of water a day and releases it at significantly higher temperatures. One thing that I haven't emphasized is that we have seen massive surges in harmful algal bloom outbreaks all throughout all of the Finger Lakes, the Great Lakes, even coastal areas. That can be directly impacted by increasing temperatures from these facilities.

So that is also harmful. It is harmful for all the wildlife and also toxic for humans.

Senator Markey. One final question, which is that some of the supplemental testimony which has been submitted today states that each Bitcoin transaction is tied to the same amount of e-waste as throwing away two iPhones. Could you talk about that?

Ms. Kelles. Yes, absolutely. The e-waste, there is some research showing a massive, exponential global increase in e-waste directly tied to cryptocurrency mining. But I would also note it is not just the existence of e-waste which in and of itself is concerning, but a large percentage of e-waste produced every year is exported from high income countries to low and

middle income countries where regulations on dismantling, recycling, and refurbishing may be lacking or even poorly enforced.

According to the WHO, an estimated 12.9 million women, and I think it was 18 million children and adolescents as young as five years old work in the informal waste sector, which potentially exposes them to toxic e-waste. Their goal in this work is often to recover copper and gold from used electronics, risking exposure to harmful chemicals such as lead, mercury, nickel, brominated flame retardants and polycyclic aromatic hydrocarbons.

So all of these are highly correlated with some health issues like stillbirth and premature birth, low birth weight and length, and exposure to lead, of course, we know has a lot of neurological issues, increasing rates of ADHD, behavioral problems, sensory integration difficulties. So huge, huge, issues that we are not discussing sufficiently with respect to the health and the escalating e-waste from this industry.

Senator Markey. Thank you so much.

Senator Ricketts?

Senator Ricketts. Thank you, Mr. Chairman.

Mr. Altenburg, so you have many times throughout the course of the day today have described this as wasteful energy. I think you said it should be used for useful work. But you also

said that a Bitcoin, once you mine it, is worth $144,000, right?

Mr. Altenburg. That is what the market value is.

Senator Ricketts. Doesn't that mean, if there is a market for it, that somebody considers it valuable because they are willing to pay for it?

Mr. Altenburg. People certainly see a cash value. But the question of what does it do productive for the economy, Warren Buffet had said in an interview not too long ago that when you buy Bitcoin, you have nothing. The only thing you really have is the hope that somebody else is going to pay more.

Senator Ricketts. What do you use the blockchain technology for, right?

Mr. Altenburg. A blockchain itself could be potentially used for a lot of different things, smart contracts was one of the things mentioned, which Bitcoin isn't currently capable of doing, but Ethereum is. Certainly recording data in a secure way.

[Simultaneous conversations.]

Senator Ricketts. You talked about before how hard it was to break that encryption, right?

Mr. Altenburg. It isn't the encryption. The blockchain is very transparent. You can see everything that is on it. What it is, what has happened it is very, very difficult to change. It is basically a write-once structure.

Senator Ricketts. Okay. So, then who are the people that find value in Bitcoin?

Mr. Altenburg. Mostly currency speculators.

Senator Ricketts. Okay, and who who are they speculating with?

Mr. Altenburg. They are buying Bitcoin hoping that somebody tomorrow will buy it for more.

Senator Ricketts. Okay, so, but somebody, you are generating this Bitcoin and then you can turn that Bitcoin in to buy other things, right?

Mr. Altenburg. Yes.

Senator Ricketts. So it does actually have value?

Mr. Altenburg. Yes.

Senator Ricketts. So somebody is willing to pay for it.

Mr. Altenburg. There is no doubt there is a market value to it. But the question is, are we actually gaining something. When we build a bridge, we have built a physical asset. When we build a car or a cell phone, there is a physical asset. Bitcoin doesn't have that. The only real value you have is potentially transaction fees as part of extending the blockchain.

But we can do all the blockchain stuff. We can have all of that without using anywhere near the amount of energy that Bitcoin uses. It is not adding anything new to the economy.

Senator Ricketts. So when you say you don't have anything

physical, do you have to have something physical to have value?

Mr. Altenburg. Again, there is a distinction between, is there a market value, yes. People are willing to spend money for it. But when we are evaluating whether this is a reasonable thing to do, people are willing to spend money on lots of things. But are they the best choice?

Senator Ricketts. So is it the government's job to tell people they can or cannot spend money on the things they wish to choose to?

Mr. Altenburg. As Senator Lummis said, in a lot of cases, the government does exactly that. We have plant sufficiency standards.

Senator Ricketts. Well, that is very different. A plant sufficiency standard is very different than saying, you can or cannot spend your money on something, right? I am not telling you you can't buy an appliance, I have standards for how you produce them, but I am not telling you you can't buy one. It seems to be what you are implying when you are talking about this Bitcoin being wasteful.

Mr. Altenburg. I am looking at it in this context of things like efficiency standards. We do that all the time for whether it is environmental reasons, for pollution, whether it is national security reasons, for energy security. There is a long history of the government making judgments about these

industries are wasteful, it is inappropriate, it does not put us in a good position going forward. I think Bitcoin is one of them. It does not bring anything unique that we need.

Senator Ricketts. Ms. Dentlinger, in Nebraska, NPPD, how do you look at different industries with regard to the rates you charge? Do you have any additional requirements on different industries? Do you treat them differently with regard to things like disclosure or anything like that? Is there an analogy here somewhere?

Ms. Dentlinger. No. We are very agnostic to whatever the industry that is actually using the industry. We have different rates for different customer classes, whether it is residential or commercial or industry. Beyond that, we are not looking into the industry.

Senator Ricketts. Who is your largest power user in the State of Nebraska?

Ms. Dentlinger. Currently, Nucor Steel.

Senator Ricketts. Okay, so Nucor Steel. And do you ask them to disclose anything with regard to their power generation?

Ms. Dentlinger. No.

Senator Ricketts. Do you actually charge them a separate rate because they are using so much power?

Ms. Dentlinger. No, actually, again, because they are using so much and using it so regularly, the rate that they pay

tends to be lower, because it is a more efficient use of our assets.

Senator Ricketts. So again, it is one of those things where as you are generating more or you have a customer who is using more energy and it is more stable, as Nucor Steel is, you are actually charging them less because it actually is more efficient to generate that power.

Ms. Dentlinger. Yes. We are cost-of-use, our rates are based on what it costs us to produce and deliver the electricity. So that is reflected in our industrial rates.

Senator Ricketts. Great. Thank you.

Senator Markey. So, I thank Senator Ricketts, I thank all of our witnesses. Of course, Nucor's emissions are captured by the EPA. That is a part of the public record, what their emissions are.

In general, I would say this has been one of the most informative hearings that the Congress has had in a long time, about a subject that is just not had the attention which it needs. I thank all of our witnesses for your great testimony today. We are going to proceed on this subject because ultimately we just need to ensure the information is out there.

Bitcoin is the first cryptocurrency, but it is not staying current with other assets like Ethereum. Its impacts are real, but its energy efficiency innovation isn't developing at the

same time. Bitcoin is like if we still insisted on using whale oil to light our homes instead of energy efficient LEDs. That is the gap between proof-of-work that Bitcoin uses, and other systems like proof-of-stake that Ethereum uses. One is 99 percent more energy efficient that the other.

So it is just good to get that out there to make it clear that there are other ways of doing business.

We are talking today about unavoidable, untracked environmental impacts. We track emissions and impacts of mines, of cars, of power plants. But we have a drain on our system with Bitcoin that isn't accounted for. Other crypto assets like Ethereum produce value while using 99.9 percent less energy.

So it is climate, it is air, it is noise, it is water, it is waste. These computer motherboards are harming Mother Earth. But we don't know the extent of the damage, we don't have anyone checking the work of crypto mining companies that argue they are helping the planet or the grid.

That is why the Crypt-Asset Environmental Transparency Act is so important, and States like New York or Pennsylvania or Massachusetts or Nebraska are taking a case by case approach to this new power sucking powerhouse industry. But we need a Federal approach just so we have the information out there as to what the climactic impacts are.

So the Senate Environment and Public Works Committee is the

ideal forum to consider legislation which would do just that. They are unlikely to have this hearing over in the Banking Committee, the Financial Services Committee. This is our job. Our job is to look at these aspects of this new technology.

I thank my colleagues for their participation in this hearing. I am very grateful to our witnesses today.

Before I adjourn, some housekeeping. I would like to ask unanimous consent to submit for the record a variety of materials that include letters from stakeholders that relate to today's hearing. Without objection, so ordered.

[The referenced information follows:]

Senator Markey. All Senators will be allowed to submit written questions for the record through the close of business on March 14th. We will compile those questions and send them to the witnesses and ask each witness to reply to the Senators by March 28th.

With that, this hearing is adjourned.

[Whereupon, at 4:19 p.m., the hearing was adjourned.]