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CLEANING UP CRYPTOCURRENCY: THE ENERGY IMPACTS OF BLOCKCHAINS

THURSDAY, JANUARY 20, 2022

House of Representatives,

Subcommittee on Oversight and Investigations,

Committee on Energy and Commerce,

Washington, D.C.

The subcommittee met, pursuant to call, at 11:30 a.m., in Room 2123, Rayburn House Office Building, Hon. Diana DeGette, [chairwoman of the subcommittee] presiding.

Present: Representatives DeGette, Kuster, Rice, Schakowsky, Tonko, Ruiz, Peters, Schrier, Trahan, O'Halleran, Pallone (ex officio); Griffith, Burgess, McKinley, Dunn, Joyce, and Rodgers (ex officio).

Also present: Representatives Castor, Pence, and Soto.

Staff Present: Austin Flack, Policy Analyst; Tiffany Guarascio, Staff Director; Perry Hamilton, Clerk; Fabrizio Herrera, Staff Assistant; Xiaoyi Huan, GAO Detailee; Rebekah Jones, Counsel; Zach Kahan, Deputy Director Outreach and Member Service; Will McAuliffe, Counsel; Elysa Montfort, Press Secretary; Kaitlyn Peel, Digital Director; Chloe Rodriguez, Clerk; Nikki Roy, Policy Coordinator; Andrew Souvall, Director of Communications, Outreach, and Member Services; Medha Surampudy, Professional Staff Member; Sarah Burke, Minority Deputy Staff Director; Michael Cameron, Minority Policy Analyst, CPC, Energy, Environment; Marissa Gervasi, Minority Counsel, O&I; Nate Hodson, Minority Staff Director; Peter Kielty, Minority General Counsel; Emily King, Minority Member Services Director; Bijan Koohmaraie, Minority Chief Counsel, O&I Chief Counsel; Tim Kurth, Minority Chief Counsel, CPC; Clare Paoletta, Minority Policy Analyst, Health; and Michael Taggart, Minority Policy Director.

*Ms. DeGette. The Subcommittee on Oversight and Investigations hearing will now come to order, and today the hearing is -- the committee is holding a hearing called, "Cleaning Up Cryptocurrency: the Energy Impact of Blockchains.''

Today's hearing will examine the energy and environmental impacts of certain blockchains used in cryptocurrency mining.

Due to the COVID-19 public health emergency, members can participate in today's hearing either in person or remotely, via online video conferencing. And I apologize, I like to be in person for these hearings, but I am under quarantine because of the COVID emergency.

Members, staff, and members of the press who are in the hearing room, though, must wear masks in accordance with the updated guidance issued by the Attending Physician.

For members participating remotely, your microphones will be set on mute for the purposes of eliminating inadvertent background noise, and members participating remotely will need to unmute your microphone each time you wish to speak. Please note, once you unmute your microphone, anything that is said in Webex will be heard over the loudspeakers in the committee room, and also subject to be heard by livestream and C-SPAN.

Because members are participating from different

locations at the hearing, all recognition of members, such as for questions, will be in the order of subcommittee seniority.

However, given the weather event in D.C., I have spoken with the ranking member, and if people have a need to leave, please let either me or the ranking member know, and we will try to accommodate you for your question period.

If at any time during the hearing I am unable to chair the hearing, the vice chair of the subcommittee, Mr. Peters, will serve as chair until I am able to return.

Documents for the record can be sent to Austin Flack at the email address we have provided to staff, and all documents will be entered into the record at the conclusion of the hearing.

The chair now recognizes herself for purposes of an opening statement.

Today the subcommittee will examine the rapidly growing energy and environmental impacts that accompany the mining of certain cryptocurrencies.

Cryptocurrencies rely on blockchain technologies, which are essentially networks made up of many computers working collaboratively to record and verify data. Blockchain technology has numerous potential applications beyond cryptocurrency that will likely make -- soon make our lives more efficient and secure. Health care records, for example,

will become more portable and accessible to patients. Energy management will improve through the use of smart contact -- contracts. And due to data being distributed across a network, instead of in a centralized location, our online information will be more secure.

New and innovative uses of blockchain technology are being explored every day, and we should continue to try to encourage them. But as this innovation continues, it is important that we keep energy efficiency and the reduction of carbon emissions at the forefront of our discussion, as always. And that is why we are here today.

Different blockchains use different methods to add new data and verify the integrity of the blockchain, and the method chosen can have important implications for a blockchain's energy use. One method in particular, called proof of work, involves millions of computers racing to be the first to solve a complicated puzzle and be rewarded a valuable prize: new cryptocurrency coins or tokens. This competitive process, and the energy consumption associated with it, is inherent to the proof of work method.

Currently, the two largest cryptocurrency networks, bitcoin and Ethereum, use proof of work. On these networks, the financial incentives to have your computer be the computer that solves the puzzle and wins the prize are substantial. For example, earlier this month, a computer

that successfully recorded a new block of transactions on the Bitcoin network was awarded 6.25 bitcoins, worth about $270,000. And in the Bitcoin network, that award happens about every 10 minutes. These high financial rewards incentivize crypto miners to constantly increase their computing power. This, in turn, increases the need for inexpensive, reliable energy.

Now, we know not all crypto mining companies respond to this need the same way. Some crypto mining companies have based their facilities in communities with cleaner and less expensive renewable energy, like hydroelectric, wind, and solar. But others have revitalized or prolonged the use of otherwise shuttered fossil fuel plants. For example, one company in upstate New York upgraded a previously closed coal-fired coal power plant to run on natural gas, a plant which now operates primarily for the purpose of the company's Bitcoin mining activities. Another company restarted two coal-fired plants in Pennsylvania in order to generate power for its crypto mining operations.

Now, given our current climate objections -- objectives, examples like this are deeply concerning. Our focus now needs to be reducing carbon emissions overall, and increasing the share of green energy on the grid. The unique energy demands of the crypto mining industry do present potential benefits, although how these will play out in practice

remains to be seen. For example, crypto miners could play an important role in balancing and stabilizing the grid.

Crypto miners have the capacity to quickly reduce their energy consumption during periods of peak demand, and this demand response capability could be vital, not only in times of crisis, like last year's Texas freeze, but also in managing day-to-day peaks and valleys of renewable energy generation. While this sounds promising, it is important to understand the degree at which this is actually being done, and whether communities can benefit from the flexibility. I hope we can discuss this today.

Another area of concern is the high volume of electronic waste generated from crypto mining, estimated at more than 30,000 metric tons from the Bitcoin network alone since 2020 -- in 2021. Most crypto mining computers are now custom made for mining activities, and they can't be repurposed for any other use. The machines become obsolete, resulting in a great deal of electronic waste that is hard to recycle or dispose of safely.

As the energy moves forward -- as the industry moves forward, it is crucial for cryptocurrency networks to identify ways to reduce the need for constant, high-volume energy use, and minimize the negative effects on the environment.

Cryptocurrency --

[Audio malfunction.]

*Ms. DeGette. -- in everyday life would likely continue to expand, and the committee should remain at the forefront of understanding and guiding that reality. We should be sure that, as we develop novel and helpful uses for blockchain technology, that we also minimize any resulting energy and environmental impacts.

I want to thank the witnesses for their testimony, and I want to thank them for their patience in waiting for this vote series to be concluded.

And I also really want to thank all of you for your expertise, because this committee, as well as all of America, is beginning to try to understand more and more the impact of this and its demands on the grid.

[The prepared statement of Ms. DeGette follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. And with that, I am happy to yield back and to recognize the ranking member of the subcommittee, Mr. Griffith, for five minutes.

And I will also ask everyone to make sure that you are muted, because of this background noise going on right now.

With that, Mr. Griffith, you are recognized for five minutes.

*Mr. Griffith. Thank you very much. Today we finally meet as a committee to do our congressional duty, conduct oversight, after a nearly four-month-long pause. It is disappointing that Democrat leadership has not allowed this subcommittee to hold hearings to address some of the nation's most pressing issues.

With that being said, I appreciate the chairwoman pushing to get our second hearing room up and running, and I look forward to working with her to tackle some of the important issues facing our country. I hope that we will start to dig into crucial oversight.

Bitcoin and other cryptocurrencies have grown increasingly popular in the past few years. One of the main reasons cryptocurrency remains successful is the technology behind it: blockchain. A blockchain is a shared ledger for recording transactions and tracking assets that protects against manipulation, ensuring valid transfers without the use of a centralized clearinghouse, such as a bank.

Blockchains have already proven to be a lucrative technology.

Cryptocurrencies that apply blockchain technology are digital money and electronic payment systems. Some estimates have found that, as of 2020, there were more than 5,100 different cryptocurrencies. Certain estimates place cryptocurrency assets at a total exceeding $3 trillion.

Policymakers should understand the cryptocurrency ecosystem, including the baseline technology, the key players, the market, and the ways in which the U.S. Government can help advance its development.

Today we review the cryptocurrency ecosystem through the lens of energy consumption. Energy is consumed when computers perform calculations to validate transactions, and a cryptocurrency is "mined.'' Cryptocurrency mining is the process by which new digital currencies are made or discovered and entered into circulation. This process often consumes large amounts of energy, due to the specialized hardware involved in validating transactions.

As prices for cryptocurrency have increased, the incentive for miners to invest increasing amounts of capital and larger computer systems to validate more transactions has also increased.

Bitcoin mining makes up the largest share of cryptocurrency mining. Bitcoin miners receive a reward in the form of bitcoins for validating transactions. This

reward is halved every four years. So today the reward is 6.25 bitcoins. As of January 2022, bitcoin traded at around $43,000, making 6.25 bitcoins worth nearly $270,000.

As the payoff has declined, more expensive and complex computer systems have been necessary to mine smaller amounts of the token. Some experts estimate bitcoin mining uses anywhere from 110 to 188 terawatts of the world's energy annually: more energy usage than some small countries. The relatively new proof of stake validation method used by many other tokens generally consumes less energy. However, some experts have voiced concerns with security and having too few validators participating.

The question is, can our current electrical infrastructure support this level of consumption?

Grid operators may need to update their infrastructure to accommodate the energy usage of some miners, which can be expensive and time-consuming. Short of updating their grid infrastructure, all grid operators have demand response programs. Most of these programs include contracts that state the cryptocurrency mining customer will turn on and off their load, depending on the demand and the availability of the electric supply. For example, cryptocurrency mining companies in Texas are enrolling in programs with ERCOT to become a controllable load resource. This can provide stability to a grid, as well as lower prices for other

customers.

Additionally, cryptocurrency miners are partnering with solar farms, wind turbines, and hydropower plants to support their operations. Often in creative ways, cryptocurrency miners have stepped in to make other energy businesses more profitable. For example, bitcoin miners have partnered with solar farms to use the excess energy the farm generates during the day.

Another example is the repurposing of orphan natural gas wells for cryptocurrency mining. Cryptocurrency companies reclaim orphan natural gas wells that otherwise would release flare gas into the air. This flare gas that produces methane emissions did not previously have a use or a value. These alliances between cryptocurrency miners and oil and gas companies could give use to the over two million orphan natural gas wells in the U.S.

However, the cryptocurrency industry is not shy of risks. Cryptocurrency invites skepticism from some because it is still a new asset subject to market volatility. These risks could potentially impact a reliant industry, or a community in which cryptocurrency miners operate. Examples of this risk include communities in eastern Washington and upstate New York, where the community bore the brunt of bad actors' mining operations through increased utility rates and health and safety risks, such as fires in apartment complexes

from unmonitored, overheating mining hardware. Though concerning, these incidents appear to be outliers in the industry.

I look forward to learning more about the industry and its impact on communities in the economy. Blockchain technology presents a transformational platform to empower American citizens, and I look forward to learning more about it.

[The prepared statement of Mr. Griffith follows:]

**********COMMITTEE INSERT**********

*Mr. Griffith. I thank the witnesses for being here today. I look forward to it, and I yield back.

*Ms. DeGette. I thank the gentleman. The chair now recognizes the chairman of the full committee, Mr. Pallone, for an opening statement, five minutes.

*The Chairman. Thank you, Chairwoman DeGette. We are here today to examine a truly 21st-century issue: the energy and environmental impacts of cryptocurrencies.

In the last decade-and-a-half, we have seen an explosion of blockchain technology and digital currencies, or cryptocurrencies. Concepts that once seemed futuristic have begun to enter the daily lives and digital wallets of everyday Americans. Bitcoin alone grew to a market cap of more than $900 billion last year.

Blockchain technology and cryptocurrency bring enormous promise, and this hearing is not intended to stifle that promise or to discourage innovation. I mean, this is the innovation committee. But we want to examine the potential environmental course of the crypto mining industry, and what can be done to address those impacts.

So right now, some blockchains are consuming enormous amounts of energy. One estimate found that the energy required to process transactions on the bitcoin network could power a home for more than 70 days. Last year there were hundreds of thousands of transactions on this network.

And just imagine the climate implications. Another estimate found that 2021 carbon emissions from bitcoin and Ethereum crypto mining were 78.8 million tons of carbon, roughly equivalent to the tailpipe emissions for more than 15.5 million gasoline-powered cars on the road every year.

And as this committee continues its work to combat the worsening climate crisis, it is critical that we examine these impacts. I look forward to hearing about the possibilities the crypto mining industry may bring in support of new renewable energy deployment, grid stabilization, and other innovations that may reduce energy consumption and have applications far beyond the crypto mining industry itself.

President Biden has set forth ambitious climate goals to reduce U.S. emissions by 50 percent from 2005 levels in 2030, create 100 percent carbon pollution-free power sector by 2035, and achieve a net-zero economy by 2050. Now, to achieve these important goals, we cannot bring retired fossil fuel plants back online, or delay the retirement of some of our oldest and least efficient power plants in support of energy-intensive crypto mining activities, particularly in light of the cleaner blockchain technologies that already exist.

We need to be thinking about ways to encourage innovations that improve our energy grid, increase the mix of clean energy supporting it, and improve energy efficiency

across industries. And this committee and Congress have taken steps to further these goals already. The bipartisan infrastructure law and the Build Back Better Act collectively provide the funding and resources our country needs to upgrade our power infrastructure and make clean energy even more affordable and accessible. These investments in our future will reduce greenhouse gas pollution, build a clean power grid, create jobs in support of the clean energy transition, and provide cheaper energy.

It is also important to focus on how crypto mining can affect the affordability of electricity for American consumers. I was struck by the example of Plattsburgh, New York a few winters ago. Crypto mining companies flocked to the community because of the cheap electricity offered through a hydropower allotment. These same companies then caused the community to quickly use up that allotment during a particularly cold winter. Then Plattsburgh was forced to purchase expensive power on the spot market, and local residents found themselves with incredibly high monthly bills, some hundreds of dollars more than usual.

While the industry has matured since, and there are now responsible actors in this space, we should be ready to collaborate and encourage innovation and investment in cleaner renewable energy.

Developing more renewable energy, increasing energy

efficiency, and managing demand on our energy grids are imperative to meeting our climate goals, and I look forward to hearing from our witnesses today on how the crypto mining industry may assist in achieving these goals, and whether it stands ready to do so.

[The prepared statement of The Chairman follows:]

**********COMMITTEE INSERT**********

*The Chairman. I yield back, Madam Chair, but I do believe this is a significant oversight hearing. Thank you for putting it together.

*Ms. DeGette. Thank you so much, Mr. Chairman. The chair is now pleased to recognize the ranking member of the full committee, Mrs. McMorris Rodgers, for five minutes.

*Mrs. Rodgers. Thank you, Madam Chair. Today marks one year since President Biden took office. For a full year, we have seen what one-party rule under the Democrats has done to our country. Inflation is at a 40-year high, gas prices have spiked to the national average of $3.28. Utility gas is almost up 25 percent, and everyday items such as beef, eggs, and chicken are up to 10 to 20 percent -- that is, if you can find them. Unfortunately, all this means is that Americans are paying more.

America has also suffered greatly on the international stage. The Biden Administration is not being tough on China. The Biden Administration reported -- they reported they had lobbied under -- against the Uyghur Forced Labor Prevention Act, but yet are refusing to hold China accountable for a COVID-19 pandemic. The Biden Administration has shown little to no interest in understanding the pandemic origins.

The Afghanistan withdrawal was another example of this Administration's failures. Tragically, President Biden left Americans and our allies behind, and consigned countless

Afghans to death and destitute under Taliban control.

And for all of Biden's tough, tough talks, he has waived sanctions on Putin's Nord Stream 2 pipeline, just days after Russian cyber criminals attacked a major U.S. pipeline.

What we see is that America's enemies are emboldened.

The Biden Administration has failed to secure our southern border. We have set records for the number of illegal immigrants crossing our border, and the amount of fentanyl flowing to our communities and killing a record number of people, children. Although President Biden tried to pass the buck to Vice President Harris, ultimately he owns the crisis.

When you look at the COVID-19 pandemic, it does not get any better. A central issue President Biden ran on was COVID-19. He promised the American people he would crush the virus. He has not. And instead, he has led with fear and force. His authoritarian actions have eroded trust in vaccines and public health. His vaccine mandates are upending our health care system, endangering patient care, and making workforce shortages worse.

Sadly, our children continue to needlessly suffer because of all these actions. Children should be prioritized ahead of political allies, and yet we have seen the CDC rely on junk science to force masks in schools, and emails revealed the CDC partnered with teachers' unions to draft

their school guidance, which has kept kids locked out of the classroom. The CDC also continues to force children as young as two years old to wear a mask, despite the WHO, UNICEF, European CDC, and other international partners advising against it. Children are paying one of the greatest costs of this pandemic, despite being the least at risk.

What we have seen is broken trust. It has broken trust with our parents, who rightfully want their children to have a normal childhood, and to be back in the classroom. We just learned in Washington State, between 2019 and 2021, the overall percentage of students who met state math standards fell by 20 percent. Only 30 percent of children in our state met standards in math. And today Governor Jay Inslee needs to answer for this. He is appearing before the Select Committee, the Select COVID-19 Committee.

My hope is that we start digging in to get answers. We are the elected representatives of the people. And yet today, this is the first subcommittee meeting of the Oversight Committee in four months. We need to be doing our job on behalf of the people. And that includes having more oversight hearings on a number of issues. What is happening, the stunning lack of oversight, is unacceptable.

Why are we not focused on doing everything we can to get our kids -- keep our kids in school? Why are we not doing everything we can to address the mental health crisis? Why

are we not hearing from this Administration about their failed COVID-19 response? Why are we not demanding answers to uncover the origins of the COVID-19 pandemic?

Despite these missed opportunities, I want to say thank you to the witnesses that are here. This is really transformational technology, blockchain. We are going to discuss the impact on energy consumption. This technology is in its early stages, and I believe that we want to learn more, to make sure that this technology develops and flourishes here. Eastern Washington has been at the forefront, and we are going to hear from Steve Wright from my home state of Washington. Thank you all for being here as we explore ways to encourage the growth of this innovation.

[The prepared statement of Mrs. Rodgers follows:]

**********COMMITTEE INSERT**********

*Mrs. Rodgers. And I yield back.

*Ms. DeGette. Returning to the topic of today's hearing, cleaning up cryptocurrency, the energy impacts of blockchain, I am now very pleased to introduce our witnesses: Professor Ari Juels, who is the Weill Family Foundation and Joan and Sanford I. Weill Professor at the Jacobs Technion-Cornell Institute at Cornell Tech; John Belizaire, chief executive office, Soluna Computing, Inc.; Brian Brooks, who is the chief executive officer of BitFury; Gregory Zerzan, who is the shareholder with Jordan Ramis P.C.

And I am now going to recognize Ms. Schrier to introduce our last witness.

*Ms. Schrier. Thank you, Madam Chair. I am really honored to introduce one of the smartest people I know, and a true leader in energy policy, Steve Wright.

Steve has a long history of innovation in the energy sector. He started his career at Bonneville Power Administration in the 1980s, and worked his way up to CEO. After more than three decades at BPA, he left to become the general manager Chelan County PUD in my district. And I believe it was a particular fondness for Rock Island Dam that drew him to Chelan. He has been a leader in energy efficiency innovations in existing power systems, and has kept clean electricity prices low for Chelan County residents. Not just that. Thanks to his leadership, 75

percent of this mostly rural county has access to public broadband.

Now, because of low electricity prices, Chelan County quickly attracted data and cryptocurrency mining companies, and Steve will tell us about Chelan County's experience with these companies, and how he worked with the community to make decisions about whether the Apple capital of the world would or should become the cryptocurrency capital of the world.

Welcome, Steve.

*Ms. DeGette. Thank you so much, Congresswoman. And thanks to all the witnesses.

Now, I know the witnesses are aware the committee is holding an investigative hearing. And when we do hold these hearings, we have the practice of taking testimony under oath. Does anyone have any objection to testifying under oath?

Let the record reflect that the witnesses have responded no.

The chair then advises you, under the Rules of the House and under the rules of the committee, you are entitled to be accompanied by counsel. Does anyone wish to be accompanied by counsel?

Okay. Let the record reflect the witnesses have responded no.

So if you are in the committee room, please rise.

Otherwise, if you are on Zoom, just please raise your right hand, so that you may be sworn in.

[Witnesses sworn.]

*Ms. DeGette. Let the record reflect that the witnesses have responded affirmatively.

And you are now under oath, and subject to the penalties set forth in Title 18 Section 1001 of the U.S. Code.

Now, at this time, the chair will recognize each witness for five minutes to provide an opening statement.

For those who are in the hearing room, the lighting system is -- you will have a series of lights in front of you. The light will initially be green. When you have one minute remaining, it will turn yellow, and then begin to wrap up your testimony. The light will turn red when your testimony -- when your time expires.

If you are testifying remotely, you will see a timer on your screen that will count down your remaining time.

And so again, thank you.

Professor Juels, I will now recognize you for five minutes.

TESTIMONY OF ARI JUELS, WEILL FAMILY FOUNDATION AND JOAN AND SANFORD I. WEILL PROFESSOR, JACOBS TECHNION-CORNELL INSTITUTE, CORNELL TECH; JOHN BELIZAIRE, CHIEF EXECUTIVE OFFICER, SOLUNA COMPUTING, INC.; BRIAN BROOKS, CHIEF EXECUTIVE OFFICER, BITFURY; STEVE WRIGHT, FORMER CHIEF EXECUTIVE OFFICER, CHELAN COUNTY PUBLIC UTILITY DISTRICT AND BONNEVILLE POWER ADMINISTRATION; AND GREGORY ZERZAN, SHAREHOLDER, JORDAN RAMIS P.C.

TESTIMONY OF ARI JUELS

*Mr. Juels. Chair DeGette, Ranking Member Griffith, Chairman Pallone, and Ranking Member Rodgers, thank you for inviting me to speak to you today. My name is Ari Juels. I am a faculty member at Cornell Tech and Cornell University. My main area of research is blockchain technologies.

If my testimony achieves nothing else today, I would like to drive home one key point: Bitcoin does not equal blockchain. The tremendous promise of blockchain technology does not require bitcoin, or it is energy intensive component, called proof of work. In fact, some of the most exciting developments in the blockchain industry today are happening outside of the Bitcoin ecosystem.

Now, there is a lot of mystification around blockchain technology, but the basic goal is actually fairly simple. A

blockchain aims to realize a kind of digital bulletin board, sometimes called a ledger. This bulletin board has some special properties. It is globally readable, meaning that everyone in the world sees all posted messages, and sees them in the same order. It is also immutable: a message once posted can never be altered or removed.

Such a digital bulletin board, as realized by blockchain, is conceptually simple, but powerful. For example, it can support a global payment system. Suppose that the messages posted to the bulletin board specify authentic money transfers. A message might say, "I, Alice, send $1 to Bob.'' Because the bulletin board is globally readable, any person in the world can determine the monetary balance of all users in the system. You just need to tally up all of the money transfers and posted messages.

Now, substitute bitcoin for dollars, and random numbers for names, and what I have presented is a grossly simplified but essentially accurate picture of how cryptocurrencies such as bitcoin work.

You could realize this digital bulletin board using an ordinary web server, the kind you interact with every day on the internet. But if that server crashes or is hacked, the bulletin board will fail. The brilliant insight of bitcoin's inventor was a way to avoid such problems using a blockchain maintained by an open community. To ensure fair

participation, and that no one individual can easily take over the system, bitcoin relies on what is called proof of work. To help maintain the bitcoin blockchain and earn bitcoin through a process called mining, you need to contribute a large amount of computation to the system. You do this by solving hard mathematical puzzles.

Unfortunately, bitcoin mining consumes a massive amount of electricity. Now, some credible estimates place this consumption today at roughly half a percent of the world's total electricity supply -- more, for instance, than the entire nation of Argentina.

The term "proof of work,'' I should say, was coined in a scientific paper I co-authored back in 1999. A decade before the advent of bitcoin, that paper already recognized the inherent waste in proof of work. The paper was, therefore, about how to recycle proof-of-work computation.

Happily, the blockchain community has devised new ways to realize blockchains without proof of work. The leading alternative, which consumes far less electricity, is called proof of stake. The number two cryptocurrency, Ethereum, plans to adopt proof of stake, and nearly all new blockchain systems already use it today to secure hundreds of billions of dollars in value.

These systems are faster than bitcoin, and support what are called smart contracts, small programs that run on

blockchains. Smart contracts are powering some of the most exciting blockchain applications, including what is called decentralized finance, or DeFi, and nonfungible tokens, or NFTs.

Bitcoin doesn't readily support DeFi or NFTs today. Again, Bitcoin does not equal blockchain.

Proof of work is heavily battle-tested, and has valuable theoretical property properties, but there are many misguided claims about it. For instance, some claim that it is critical to achieving decentralization, meaning broad participation.

But bitcoin and, in fact, many blockchain systems are, in some key ways, notably centralized. This is a challenge the whole industry is working on. For example, in the specific case of bitcoin, just four entities, called mining pools, today control a majority of the mining power and, thus, technically can control the whole system.

In summary, the bitcoin community deserves our deep gratitude for introducing blockchains to the world, but we have far more energy efficient alternatives than proof of stake. For the sake of the environment and our energy infrastructure in the United States, I believe that we need to embrace these newer options. Thank you.

[The prepared statement of Mr. Juels follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. I thank the gentleman. Mr. Belizaire, you are now recognized for five minutes.

TESTIMONY OF JOHN BELIZAIRE

*Mr. Belizaire. Chair DeGette, I hope you feel better. Ranking Member Griffith and members of the subcommittee, thank you for convening this important hearing, and for inviting me to testify today. My name is John Belizaire, and I am the founder and CEO of Soluna Computing. We are a developer of green data centers for cryptocurrency mining and other batchable computing.

The point I want you to remember from my testimony today is that crypto's energy consumption is a feature, not a bug. You are appropriately exploring the narrative that the energy demands of cryptocurrency will destabilize our grid, and I am here to tell you that the narrative is wrong. Crypto computing can be a catalyst for clean energy development, which will reduce pollution and create local jobs. You have agency in this debate, so I am glad you are joining the conversation.

I am a technologist and an entrepreneur. I sold my first startup company when I was 28 years old. Today I run a company which builds data centers to absorb clean energy that would otherwise go to waste. We convert wasted, or what is known in the industry as curtailed, clean electricity, into low-cost global computing. Our facilities process data that can discover new drugs, secure digital assets such as bitcoin

and other cryptocurrencies, or enable Alexa to play your favorite song.

The journey that led me here started in Morocco, where I was developing a major wind project. Morocco is great. The grid wasn't capable of handling the power we would produce. In fact, we discovered, through research, that computing was the perfect, immediately deployable solution to prevent our energy from going to waste. We figured we are not the only people to have this problem.

In fact, curtailed energy, it turns out, is a massive problem for clean energy developers. Most people don't know this, but up to 30 percent of power generated by solar and wind farms can be curtailed or wasted, which shrinks their profitability. The reason is because our grid is inflexible. It was designed on an antiquated architecture of equalizing supply and demand.

So as we ride into the clean energy future in the back of a Tesla, the question is, will we limit ourselves to just batteries and transmission to help the grid evolve? We need immediately available solutions, and this is where crypto mining and batchable computing comes in.

Now, let's talk about bitcoin. Today, the bitcoin protocol serves as a crucible for the financial freedom of millions of people. At the heart of this protocol is a process known as proof of work mining. This computing

intensive process is not a waste. In fact, the energy used to perform the computing provides proof that a miner earned the right to validate a new block and add it to the chain. The entire system is designed to encourage participants to protect the network, rather than attack it. So, as I said earlier, it is a feature, not a bug.

Another important feature about crypto mining is that it can be batched, or interrupted, paused. Unlike traditional data centers, crypto data centers don't have to run 24/7, adding nonstop load to the grid. The ability to pause processes allows us to introduce a new type of load to the grid: flexible load. Flexible load can ramp up and ramp down, as needed, thereby increasing grid resilience. So we see cryptocurrency and computing's ability to provide this flexible load as a solution to one of the biggest problems in renewable energy today.

You know, I frequently talk to wind and solar developers, and here is what they tell me. First, they are all concerned about revenue. The grid is so congested that projected curtailment makes their returns uncertain. Second, I am not the first bitcoin miner they have spoken to, which tells me that energy developers are beginning to view data centers as a path to additionality. In other words, our data centers are the catalyst for building a clean power plant that would otherwise not get built.

Computing is a better battery, so computing is ready today to allow renewables to scale to their full potential. So as you learn more about blockchain and cryptocurrency, I encourage you to zero in on that opportunity. You are in a position to shepherd that transition to clean computing and a sustainable blockchain. It is time to expand our conventional thinking where we look at our grids.

I welcome the legislation that incorporates flexible computing, along with transition -- transmission and batteries into grid infrastructure. And we also need more grid-scale programs that enable these types of new flexible load solutions to be added to the grid.

I want to thank you again for the invitation to testify before this important committee, and I look forward to joining my fellow witnesses in answering questions you might have.

[The prepared statement of Mr. Belizaire follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. Thank you so much.

The chair is now very pleased to recognize Mr. Brooks.

Mr. Brooks, you are recognized for five minutes.

TESTIMONY OF BRIAN BROOKS

*Mr. Brooks. Thank you very much, Chairwoman DeGette, Chairman Pallone, Ranking Member McMorris Rodgers, Ranking Member Griffith, and members of the committee. Thanks so much for having me here to talk about the energy impact of blockchain technology and related cryptocurrency activities, and particularly bitcoin mining.

Bitcoin is important because it introduced the world to the concept of a fully decentralized, secure, trustless system of financial value exchange that turns on proof of work not as a necessary evil, but as a positive feature of its design. And I look forward to exploring these concepts with you today.

My name is Brian Brooks, and I spent much of my career in traditional finance, culminating my service as acting U.S. Comptroller of the Currency. I also served as chief legal officer of Coinbase, and currently serve as CEO of BitFury Group. BitFury, directly and through our subsidiaries, is one of the most energy efficient bitcoin miners in the U.S. and globally. More about that in a few moments.

I view the subcommittee's topic today through two lenses.

First, in assessing environmental concerns about bitcoin mining or, frankly, any other energy use, not all energy

consumption is created equal. Would we care, for example, that an activity consumes a lot of energy if 100 percent of that energy came from renewable sources? Presumably not. So if bitcoin consumes an energy mix that is roughly twice as sustainable as the U.S. electric grid as a whole, that is a more relevant fact than the mere amount of energy that it uses. And even more important are the incentives that bitcoin creates to generate more renewable production.

The second lens is we are a market economy in this country, so we should think deeply about the economic productivity created by bitcoin or anything else per unit of energy consumed. Thus, for example, if bitcoin competes as a store of value with gold, does the energy used in bitcoin mining produce more economic value per unit of energy than gold mining?

Or if bitcoin competes with traditional finance as a means of payment, or as a source of credit, does bitcoin produce more economic value per unit of energy than financial services?

The answers might surprise you, as I will point out in a moment.

Now, to be sure, bitcoin's energy consumption is not trivial, but it is very small compared to many other energy uses that no one questions. Now, I am not going to belabor the usual comparisons that you hear to clothes dryers, or

holiday lights, or that sort of thing. That would trivialize an issue that the committee is talking about, which is an important issue. But what is clear is that the 188 terawatt hours used by bitcoin last year out of about 155,000 terawatt hours consumed globally for all uses, was sourced more sustainably than other uses on average.

So, for example, the energy mix used by bitcoin mining was about 58 percent sustainably sourced last year, sustainable under the International Energy Agency definition including wind, hydro, solar, nuclear, and with carbon offsets, compared to 31 percent for the U.S. energy grid, as a whole. And BitFury's specific numbers are in line with those rough ratios.

Now, even more relevant than Bitcoin's current energy use is the incentive effect it has on the future production of renewable energy. Bitcoin miners seek low energy costs, and the lowest cost always comes from excess capacity, which can include wind and solar energy, and energy lost in the transmission and distribution process, among other things.

As just one example, in 2020, in California, where I live, one-and-a-half million megawatt hours of solar production was curtailed, meaning wasted, because production exceeded demand. And the U.S. grid loses literally thousands of terawatts a year due to inefficient transmission. Now, because bitcoin miners are easily able to locate near the

source of production, these kinds of excess capacity sources can be turned into economic value through bitcoin mining. And this has the effect of taking what can be an unprofitable business -- for example, solar -- and making it profitable.

Put differently, if we want more wind and solar in this country with less need for government subsidy, bitcoin can be part of the solution.

Now, bitcoin mining produces a series of other secondary effects, which I detail in my written testimony. These include grid stabilization, incentives to improve ASIC chip efficiency by multiple orders of magnitude, and new technology development for things like immersion cooling, something that my company has innovated.

Now, an idea sometimes circulates that somehow we could have all of the positives without the energy usage if we would just abolish proof of work, and migrate blockchains exclusively to proof of stake protocols. As I noted in my written testimony, proof of stake is terrific, but it is not a substitute for proof of work, which exists for an entirely different set of purposes, and without which innovations like decentralized finance would likely not exist.

Let me just conclude by comparing bitcoin to the economic value of other uses of energy, because that, ultimately, is the question for the committee. Bitcoin uses a certain amount of electricity to produce $1 trillion of

value. And what you will find, as noted in some of my testimony, is that the aviation industry uses something like 50 times more energy per unit of value than does bitcoin. The global financial services and insurance industry uses roughly the same amount of energy per unit.

And you will note there is a little bit of glitchy data at the very end of my written testimony, which you have corrected now in the record, but I look forward to talking to you about the economic framework within which energy usage for bitcoin mining and other usages ought to be talked about.

Thank you so much for having me. I look forward to the discussion.

[The prepared statement of Mr. Brooks follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. Thank you so much, Mr. Brooks.

I am now very pleased to recognize Mr. Wright for five minutes.

TESTIMONY OF STEVE WRIGHT

*Mr. Wright. Chair DeGette, Ranking Member Griffith, Chairman Pallone, Ranking Member McMorris Rodgers, and members of the subcommittee, thank you for the invitation. My name is Steve Wright. I am a former CEO of Chelan County Washington Public Utility District and the Bonneville Power Administration.

BPA is a Federal agency that operates at the wholesale level. Chelan is customer owned, has low electric rates, and has built a high-speed internet system.

Around 2014 we noticed cryptocurrency miners establishing a presence in Chelan County. These were small operations in shipping containers, vacant small businesses, and residences. Over time, mining operations grew much larger into requests for tens or even hundreds of megawatts.

When asked why miners were coming to Chelan, we generally heard two answers: low electric rates and availability of high-speed internet. These mining operations created reliability, safety, and cost recovery challenges, due to the large electricity use and the portability of the mining machines.

Chelan held over 35 public meetings to discuss crypto mining, informing the community and educating ourselves. Included were expert discussions regarding the cryptocurrency

business model. This appeared to leave most of our customer owners more perplexed than satisfied.

In late 2015 an aluminum plant in our county curtailed operations, leading to interest in economic development. But while not unanimous, we heard substantial reservations from our community about supporting crypto mining, including stranded asset risk due to the portability of the mining machines, a relatively low number of local jobs per unit of electricity consumed, uncertain tax benefits that appeared modest, relative to the electric system cost and risk, frustration with the lack of regard for local health and safety by some miners, interest in potential blockchain applications paired with concern about reports of cryptocurrency being used for nefarious purposes, questions how future government regulation would impact the sustainability of cryptocurrency, and questions whether cryptocurrency represented the best use of hydropower as we transition to carbon reduction strategies.

Three elements made mining unique, compared against other loads. The mining machine is roughly the size of a shoebox. This translates into ability to fit into various spaces, using up available transmission and distribution capacity. There is an energy use intensity index that was frequently more than 500 kilowatt hours per square foot per year, versus a typical grocery store at less than 50. And

the ability to reduce operations or move on short notice when the electric infrastructure is generally long-life, capital intensive assets.

To address crypto mining risk, Chelan adopted rates that included upfront payment to avoid stranded asset risk for transmission and distribution, rates based on forecasts at electricity market price indices, and pricing for unusual risks. Chelan now serves less than nine megawatts of crypto mining.

The vast majority of Chileans customer owners have been supportive of the PUD's approach, and recognize that achieving high customer satisfaction is the primary objective for a consumer-owned utility.

I would offer four observations regarding both power system impacts.

First, crypto electricity usage varies dramatically by coin, which is worth discussion, given the national commitment and substantial utility funding that is dedicated to energy efficiency.

Second, clean energy resources are gaining value in electricity markets, while carbon-emitting generation is losing value. This appears likely to push crypto production toward fossil-fired resources for at least the near term.

Third, the ability to modulate crypto electric usage would be valuable -- system increasingly reliant on variable

generation. Chelan, however, did not receive serious modulation offers, which may be related to a desire to run continuously, due to the short lifetime of mining machines.

And fourth, crypto operations locating where there is short-term, underutilized transmission could be a benefit to the system. However, collaboration will be essential to avoid a growing mining industry from exacerbating an already very difficult national challenge to build new transmission.

So in conclusion, what we witnessed was a relatively immature industry that will evolve. Cryptocurrency mining does create potential costs for a utility' other customers, but we believe that can be managed. Whether crypto mining provides adequate value to overcome the cost of risk mitigation is a question yet to be answered, from Chelan's experience.

Issues for the bulk power system include how to encourage electricity-efficient production of cryptocurrency, establishing wholesale market rules, promoting demand response that could take advantage of crypto production flexibility, addressing transmission planning and expansion cost allocation for portable large loads, and considering the impact on carbon emission reduction strategies from crypto mining that focuses on least-cost production strategies.

Finally, whether cryptocurrency's value to society is sufficient for a community to want mining operations in their

area was debated in Chelan extensively and, at best, left many of our customer-owners perplexed.

Thank you for the opportunity to share our thoughts. I look forward to your questions.

[The prepared statement of Mr. Wright follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. Thank you so much.

Mr. Zerzan, you are now recognized for five minutes.

TESTIMONY OF GREGORY ZERZAN

*Mr. Zerzan. Thank you, Madam Chair, Chairman Pallone, Republican Leaders Rodgers and Griffith.

When your last name starts with Z, your greatest fear is that you are going to be introduced in alphabetical order. So everyone has already spoken on a lot of the topics I cover in my testimony. So to be brief, I will summarize what I hope are the main takeaways from my testimony at this hearing.

My name is Gregory Zerzan, I am a shareholder in the Pacific Northwest law firm of Jordan Ramis. I previously served as acting assistant secretary of the United States Treasury, as principal deputy solicitor of the United States Department of the Interior, and as counsel to three different congressional committees, including the privilege of this one.

So bitcoin is a transformative and revolutionary innovation. But it is just one use of the larger technology called the blockchain. And the blockchain has the potential to fulfill the dream of the internet stated by Tim Berners-Lee, the father of the World Wide Web, and that potential is an internet where individuals own and control their own data.

The beauty of the blockchain is it is a distributed

computer, meaning everything that you can process on the servers of one large corporation -- say, a social network company or a search engine -- you can do through the distributed computing services of the blockchain. So blockchain, ultimately, is a pro-consumer technology that empowers the users in a way that was the original intent of the World Wide Web.

Now, concerns have been raised about energy use, but the truth is we are an innovative economy, and we have been innovating in terms of our sources of energy production. So America's energy portfolio has become increasingly less carbon intensive, and we are innovating in the ways that we achieve consensus and process transactions on the blockchain. And there is no reason to believe those innovations won't continue.

So the final takeaway, if I could leave one with this committee, is bitcoin is one cryptocurrency, but not all cryptocurrencies are meant to be a cash substitute. Indeed, cryptocurrency is simply the oil that lubricates the blockchain. It is an internal economic incentive for the computing power that the blockchain represents. And so a lot of the conversation about regulation of cryptocurrency has been among financial regulators. And I submit that that is not necessarily appropriate.

Cryptocurrency is code. Its purpose is to make

blockchains run efficiently. And so the idea that we might strangle the innovation of the blockchain by imposing inappropriate regulation on it is very real. And I believe there is a way to overcome that regulatory uncertainty, primarily by understanding that laws such as the Federal Trade Commission Act, which protect consumers against unfair and deceptive acts and practices, apply to transactions in code like cryptocurrency.

And I would suggest that, while there are some applications in the blockchain that are financial products, that is not by any means necessarily the case with all cryptocurrencies and transactions that occur on the blockchain.

It is a privilege to be here today in front of my own committee. It looks a lot different from this side of the table, but thank you so much for having me here.

[The prepared statement of Mr. Zerzan follows:]

**********COMMITTEE INSERT**********

*Ms. DeGette. Thank you. Thank you so much. Actually, we put you last not because you start with Z, but because you -- as a former staffer to this committee, we knew that you would give value added, and back clean-up. So thank you so much for that.

It is now time for members to be able to ask the panel questions, and so the chair will recognize herself for five minutes.

Cryptocurrencies and blockchains are, obviously, complicated concepts to those of us who don't deal with them every day, but I think it is really important, and this panel has really helped us already to understand exactly what we are talking about when we use phrases like "proof of work.'' And I thought all of you were very helpful with that.

Professor Juels, as you said, you were one of the researchers that coined the phrase "proof of work'' in your paper, back in 1999. And as you said in your testimony, that paper "recognized the inherent waste of proof of work.'' Can you explain very briefly what is it about proof of work that creates "inherent waste''?

And is there a way to do the proof of work technique that doesn't involve this waste?

*Mr. Juels. Yes, thank you. That is an important question.

Maybe the best way to explain it is to say we have all

had the frustrating experience of solving these little puzzles online, you know, where you pick out images of cars or bridges to access a website. This is to ensure that you are a human being, and not a bot pretending to be many people in attacking the website. Proof of work is, basically, a type of puzzle that prevents one computer from pretending to be many computers. It is effective, but, as we have discussed, in large systems it consumes a large amount of energy and computation.

The resources in proof of work are wasted in the specific sense that they serve no other useful purpose. In other words, no useful purpose outside the system that they are meant to protect. There is an opportunity cost in the computational energy resources used for proof of work that could potentially be used for other goals.

But more importantly, as I testified, we have energy efficient alternatives to proof of work, like proof of stake, right? This is sort of analogous, I guess, to --

*Ms. DeGette. We are going to get to that. Yes, we are going to get to that in a minute. Can I just ask you a question?

Now, there is no requirement -- it is true, when you do proof of work, you can use alternative energy sources. But the -- it is not inherent in that type of process. And in fact, what happens is bitcoin and other cryptocurrency

networks, they don't -- they are going to wherever they can find the cheapest energy, is that right?

*Mr. Juels. That is right. Rather, I was saying something slightly different, which is that there are alternative methods to maintaining blockchain --

*Ms. DeGette. I understand.

*Mr. Juels. Okay, yes.

*Ms. DeGette. I understand that.

So Mr. Belizaire, you say that we should consider crypto's energy consumption as a feature, not a bug. Can you very briefly explain what you mean by that?

[Pause.]

*Ms. DeGette. There -- you need to unmute.

*Mr. Belizaire. Chairwoman, I was referring to the design of the network. The energy consumption is architected into the system, as the -- as Professor Juels mentioned to you -- create certain types of behavior, protect the security of the network, and really lock in the value that, ultimately, the asset creates.

That same feature can be creatively applied to other problems, because there is this high energy consumption. The participants will, you are right, search for lower cost of power. But guess what? Renewable energy is now becoming the lowest cost of power around the globe.

*Ms. DeGette. Okay, well, let me -- Mr. Wright, let me

ask you about that to you, because in your testimony you talk about that it is not necessarily true, that renewable energy is always the lowest cost of power. Is that right?

*Mr. Wright. Yes, that is correct. So in --

*Ms. DeGette. Okay.

*Mr. Wright. -- clean energy gaining value, and fossil generation is losing value.

I will say I think there are real opportunities here with cryptocurrency production to be used for demand response. We have a huge challenge in front of us in the electric utility industry to try to figure out how to make all these variable energy resources work, and we need more demand response, but we don't know --

*Ms. DeGette. Yes, I agree. I am sorry. I just have -- I want to ask a question of Mr. Brooks, because -- I guess I have two questions.

Number one, do you agree that proof of work can be wasteful?

And also, very briefly, why do you think that, for example, bitcoin and these other cryptocurrencies cannot shift to the proof of stake method?

*Mr. Brooks. Chairwoman DeGette, thanks for the question. Those are both great questions.

I begin with the measure of waste in an economic activity is whether the activity is producing a value that

other people are willing to pay for. And so bitcoin is vastly the largest cryptocurrency by market capitalization, by a huge amount, and, you know, over the last 6 months has varied between 800 billion and $1.2 trillion. So I begin by saying it is clearly not wasted. It is an asset that large numbers of people are willing to pay for a variety of reasons we could talk about.

In terms of whether there is an alternative, whether we could just shift to proof of stake or do this a different way, the problem of proof of stake versus proof of work is that proof of stake, though it is a set of very, very valuable innovations, has at its core a dependance on trust of who the stakeholders are. The original vision of bitcoin was this is the only trustless network, so I don't have to care who my counterparty is or who the major shareholders are. The next bitcoin is given out based on a lottery, right?

So in a proof of stake network, 51 percent of the ownership of that network can rewrite the ledger, can steal everybody else's money, can change the code in ways that are not favorable to the minority shareholders, just like they could in a business corporation. That is not possible in bitcoin --

*Ms. DeGette. Okay, I am sorry --

*Mr. Brooks. -- because of proof of work.

*Ms. DeGette. Mr. Brooks, I am so sorry, I have got to stop you because we are out of time. But I know we are going to want to explore that concept more.

And with that I will recognize the ranking member for five minutes.

*Mr. Griffith. Madam Chair, if we could go to Mr. McKinley --

*Mr. McKinley. Thank you, Mr. Chairman, and thank you for Dr. Burgess for also waiving the time --

*Ms. DeGette. I will recognize Mr. McKinley for five minutes.

*Mr. Griffith. Thank you, Madam Chair.

*Mr. McKinley. Thank you for all -- for waiving, and for giving me the opportunity to go earlier.

So, look, as the ranking members have already stated, it has been nearly four months since this subcommittee held a meeting. And last year, with the a president and the Democrat Party in the majority, this committee held only 74 hearings and markups.

Now, contrast that with 2017, with President Trump's first year in office, and when Republicans had the majority. The committee held 106 hearings and markups. That is nearly 50 percent more. Democrats talk about transparency, and -- but with such obvious inaction, they give the impression to the American public that they are trying to hide something.

Look, with problems being discussed at breakfast tables all across America -- rising energy costs, empty shelves in grocery stores, runaway inflation, a shortage of health care workers, the opioid crisis, open borders -- it seems coming across that the Democrats want to divert attention from Biden's failures by talking about cryptocurrency data centers.

Look, I have had thousands of district meetings with the consumers and people back in West Virginia. No one has ever raised the issue of cryptocurrency being a concern to them.

But I will humor you, Madam Chairman, and try to stay on topic here. Cryptocurrency data centers can operate 24/7, and they can use as much as 500 megawatts of power. But they are being advised to use green energy, to depend on renewables only. Now, doing that would redline fossil-rich-dependent states like West Virginia and elsewhere. It is discriminating against states across this country.

West Virginia doesn't have sufficient renewable energy, and that argument applies also to the PJM market, which extends from Delaware all the way to Chicago. That -- PJM has already testified they only have -- 10 percent, 11 percent of their market, their profile, is renewables. So are we discriminating against them? Are we red-lining all these states from having a cryptocurrency data center, if we are requiring them to use or causing them to use renewable

energies? We are picking winners and losers.

So Madam Chair, I just wish this committee would go back to the basics, and let's conduct oversight on issues that are really being discussed at the kitchen tables.

But Mr. Zerzan, if I could ask you a question, witnesses have discussed using natural gas flared from oil wells, and how cryptocurrency's operations could use the residual gas in abandoned wells. Well, but there are permanent obstacles. And even if companies tried to use this flared or residual gas, the Democrat Party still wants to eliminate fossil fuels for power generation by 2035 in the Clean Future Act.

So if they are successful with this, would the companies, these cryptocurrency companies, be able to rely on wind and solar without having battery storage?

We know battery storage is still in its infancy, it is still growing up. So in places like West Virginia and the PJM market, are we going to -- are we hurting those as being possible job sites?

*Mr. Zerzan. Thank you, Congressman, for your question.

So in 2019 the United States achieved American energy independence for the first time since the 1950s. And, in fact, we were a net exporter of energy. In 2019 the United States also emitted the fewest greenhouse gases since 1992. It is obvious that the energy portfolio in the United States is becoming less greenhouse gas intensive, but it is also,

without question, the case that we rely on fossil fuels to maintain a reliable, stable grid in the United States.

I think we have heard testimony today that points out accurately that the wind doesn't always blow. We don't always have the sunshine. Sometimes when those things happen, it happens too much. And so that energy would otherwise be wasted. And one of the great things about, you know, cryptocurrency technology and processing is that it utilizes energy in many cases that would otherwise be discarded.

But having said that, it does not, I think, behoove anyone to pursue energy that is more expensive than the best price they can get on the market. And whether that is natural gas, whether that is coal, whether that is, you know, solar or wind or hydro, cheap energy is one of the distinguishing things about American industry that gives us a economic advantage.

*Mr. McKinley. Thank you. I yield back.

*Ms. DeGette. I thank the gentleman. The chair now recognizes the chairman of the full committee, Mr. Pallone, for five minutes.

*The Chairman. Thank you, Chairwoman DeGette. I am going to ask everybody to kind of respond quickly, because I have a lot of questions, and we couldn't get through it in five minutes.

But my concern, obviously, about -- is about the intensive use of power for mining certain cryptocurrencies, and the potential related to the effects on our climate. And in preparing for this hearing I found it striking there were very different estimates for just how much electricity the crypto mining industry consumes, and how much carbon is generated by it. And it is difficult to assess how big of an issue the industry's power futures presents if we are using radically different estimates of power consumption.

So let me start Mr. Belizaire.

As I understand it, knowing how much electricity your facilities are using and the generation sources of electricity are both central to running your business. Can you talk about -- you know, briefly -- the concern of very high power consumption across the crypto mining industry, and other particular estimates that you find more or less credible in that regard?

*Mr. Belizaire. Well, the -- Chairman, thanks for the question.

There are varying data sources to get the -- this information. The Cambridge Report tracks this, and they try to put out updated estimates on an annual basis. I have seen ranges of a third of a percent to, you know, approaching half of a percent. But I submit that the data suggests traditional data centers use three percent of the world's

global usage. We don't really have an issue with that, because data centers seem to have a key role, an important role in our everyday lives. And so I think --

*The Chairman. Any other particular estimates that you find more or less credible in trying to resolve the issue here, or not really?

*Mr. Belizaire. I don't know, I can't speak to it, but I can have my team send you the ones that we use --

*The Chairman. All right, yes, get back to us. All right --

*Mr. Belizaire. We will do that.

*The Chairman. -- let me go to Mr. Juels.

Mr. Juels, in your written testimony you note that the Cambridge Bitcoin Electricity Consumption Index provides a good estimate of how much electricity is being used for bitcoin. Can you explain why you find that particular index credible? I am trying to get to the bottom of which source might be more credible here.

*Mr. Juels. Yes. So I have briefly reviewed their methodology, and it seems sound to me. There is no direct way to estimate or ascertain the amount of energy that the bitcoin network is using. We have to infer it, and we infer it according to what is known as the hash rate, the amount of computation in the network, and then back out the electricity consumption by making certain assumptions about the types of

machines that are known as mining rigs that are used. And the Cambridge Bitcoin Electricity Consumption Index seems to do that in a way that appears to me, in my technical judgment, to be --

[Audio malfunction.]

*The Chairman. All right, thank you.

Mr. Wright, I wanted to turn to something else, and that is the potential impacts of these activities on affordability. You mentioned in your testimony that the growth evolution of the crypto mining industry presents -- and I quote -- "a unique set of low-growth challenges,'' and that "not managing these risks can lead to significant cost exposure for utilities and other customers.'' So, Mr. Wright, can you explain what some of those risks are?

How can communities make sure that everyday ratepayers do not find themselves bearing the cost of the bitcoin -- of this cryptocurrency industry?

*Mr. Wright. Well, there are three elements of an electric utility's rates: transmission, distribution, and generation. With transmission and distribution, if we get --

[Audio malfunction.]

*Mr. Wright. -- that locates the portable load, move away on short notice, exposure --

[Audio malfunction.]

*Mr. Wright. -- and then there is nobody there to pay

for it, other than the existing customers. That is particularly true for our consumer-owned utility, where the consumer-owned utility's customer is actually putting up the capital to support the program.

For generation it can come in two ways. One is whether you, similarly, have to build generation, and whether that could become a stranded asset. Or alternatively, if you were going to sell generation, which generally gets more value in the market from selling long-term, and you wouldn't be able to do that anymore because you would be getting a -- dedicating it to a load that could be portable and leave town on short notice.

[Audio malfunction.]

*The Chairman. -- our committee to make sure that everyday ratepayers don't find themselves bearing the cost. Are there are certain things they can do to prevent that?

*Mr. Wright. Yes. So I think this is what we did with --

[Audio malfunction.]

*Mr. Wright. -- process. One --

[Audio malfunction.]

*Mr. Wright. -- traditional load. So we have a --

[Audio malfunction.]

*Mr. Wright. -- aluminum plant -- pick up and move to --

[Audio malfunction.]

*Mr. Wright. -- deal with, by making sure that -- rate-making, and collecting money up front, and --

[Audio malfunction.]

*Mr. Wright. -- sell at a market rate for electricity based on short-term market prices.

*The Chairman. All right, I have to say I couldn't -- it was garbled, your response. So, you know, it is -- I am sure it is the internet.

Can you send me something in writing to answer that question, how communities make sure that everyday ratepayers do not find themselves bearing the cost, if you would? Because I don't know that -- I couldn't understand what you said, and I don't know that anybody transcribed it properly. So if you could respond in writing, I would appreciate it. Thank you.

*Mr. Wright. Thank you, will do.

*Ms. DeGette. I thank the gentleman. The chair now recognizes the ranking member, Mrs. Rodgers, for five minutes.

*Mrs. Rodgers. Thank you, Madam Chair. Thank all the witnesses for being here.

Mr. Zerzan, I wanted to start with you, and just -- I appreciated in your written testimony you talk about how blockchain technology has the potential to empower consumers

by giving them control over their own information, rather than allowing their data to be controlled by large corporations. Can you explain how blockchain accomplishes this?

*Mr. Zerzan. Thank you very much, Leader Rodgers. The amazing thing about blockchain is it operates as a distributed computer, meaning it can do all the things that a traditional computer can do.

So as I said in my opening statement, you know, right now there are about five companies that really control the internet as we think of it, and they have their own servers, and our information is in those servers. Well, the great thing about blockchain is it distributes that power across the network. So you can think of the entire network as the computer that is doing the transactions. And in that circumstance, individuals own their own data. They control their own data, and they choose if they want to sell it to someone, if they want to pass it on to someone. All of that is under the control of the consumer, and no one else can monetize their data.

So in many ways, that innovation, turning distributed computers into a giant server, is one of the most radical and potentially transformative innovations in our lifetime.

*Mrs. Rodgers. Thank you. And just as a follow up -- and I wanted to ask you and Mr. Brooks -- there was a recent

report that found cryptocurrency-related job postings in the U.S. surged an unbelievable 395 percent, just between 2020 and 2021. The job growth has outpaced the wider tech industry, which saw an impressive 98 percent jump. This job boom comes as a record 30 billion in investments poured into the industry.

So would you just speak to the government regulating the industry in this early stage, and what you think would happen to the job growth and investments?

And to Mr. Brooks, what is the long-term utility of the expertise required for crypto jobs?

*Mr. Juels. Thank you very much. The job growth is phenomenal and, as you point out, it accompanies the general interest in crypto.

And the important thing to remember is that a cryptocurrency is the oil that lubricates the blockchain. In some cases, such as bitcoin, it is designed to be a substitute for cash. In other cases, it is simply designed to be the mechanism that incentivizes people to distribute their computing power to this broader network. So we can expect there is going to be increasing interest in this innovation, because it is fundamentally a software innovation. It is a coding innovation.

So were we to apply what I would say are inappropriate regulations -- for instance, financial regulations -- to the

whole mass of cryptocurrencies, I think we would largely drive this technology into other markets.

*Mrs. Rodgers. Okay, thank you. Actually, I am going to move on.

I am sorry, Mr. Brooks. I am going to move to Mr. Wright because he is from Washington State, he is a friend, and just has been a great leader on energy issues in the Pacific Northwest, where we enjoy some of the lowest electricity rates in the country. And I just wanted to make sure that I gave him a chance.

I want to talk -- I wanted to ask Mr. Wright just to talk about your experience with crypto mining when you served as -- as you serve as CEO of Chelan County Public Utility District, and just speak to those experiences and how you believe they are representative of crypto mining in the U.S., and how you believe any negative impacts can be addressed or managed.

*Mr. Wright. I have attempted to change my internet connection, so I am hoping I am going to c52085410me through a little clearer this time than I did for Mr. Pallone.

So number one, I think that -- I want to emphasize that we experienced a lot of what I would call an immature industry. I mean, we started with this in 2014, 2015, when it was still -- the industry was still learning how to operate.

The key thing is we had a lot of folks come to town, highly capitalized and not very well capitalized. And none of them really hung around, and that created a fair amount of frustration for this community. But there was also a promise that was there that people saw: the potential for blockchain technology.

And I will associate myself with the comments separating the difference between blockchain and bitcoin. We are -- we have tree fruit here. People understand food safety. They are trying to figure out how to track fruit from tree to shelf. Blockchain seems to have great potential for that, so there is a lot of opportunity that people saw.

Bitcoin, however, I think there was a lot of concern, candidly, about the potential for this decentralized and unregulated currency, and what could be done. And a lot of reports in the press about nefarious activities associated with cryptocurrency.

So when folks said to us, "Well, we would like for you to be the cryptocurrency capital of the world,'' I would say there was a skeptical reaction to whether that is what we wanted to be or not.

[Audio malfunction.]

*Ms. DeGette. Okay, the gentlelady yields back. The chair now recognizes Ms. Kuster for five minutes.

*Ms. Kuster. Thank you very much, Chairwoman DeGette,

and thank you for holding this important hearing today. And I want to thank our witnesses for their presence and presentation.

Today's hearing marks the first opportunity for this subcommittee to discuss the rapid utilization of cryptocurrencies and the environmental impacts associated with their use.

With roughly 300 million people using cryptocurrency around the world, over 6,000 different digital assets, and greater adoption and utilization by companies willing to accept crypto as payment for products and services, it is impossible to ignore the growth of this industry in recent years.

Cryptocurrencies have the capacity to support unbanked citizens in countries with weak or corrupt financial institutions, and the decentralized nature of blockchain has the ability to empower individual investors in every corner of the planet.

But with this rapid growth comes questions about the sustainability of this industry and the underlying energy consumption needed to keep currencies operating, to validate transactions, and to keep blockchains running. This, too, cannot be ignored.

While we know there are some bad actors in this space that utilize carbon-intensive mining efforts, there are

industry leaders who are focused and committed to reducing carbon emissions. This industry has matured rapidly over the last 10 years, and what started as people mining bitcoin in their home computers has grown into the types of companies represented here today. Some mining companies are even publicly traded on Wall Street, and are announcing major capital investment projects across the country.

Despite this, the industry is still new to many Americans.

Mr. Brooks, you have spent time at a cryptocurrency exchange, you are now CEO of a blockchain service company. This gives you a broader lens on the industry. What are some of the innovations you see in this space that might have applications out of bitcoin mining?

*Mr. Brooks. Well, thank you very much, Congresswoman. I really appreciate that question.

What I would tell you is, when I first encountered the crypto industry about five years ago, maybe a little bit more than five years ago, I think many people believed that the point of crypto was for asset speculation. Maybe it was even for money laundering. But they thought it was a solution in search of a problem. And I think, five years later, people have figured out that decentralization is what crypto is all about. And Bitcoin, of course, was the original and most decentralized of all of the blockchains.

What I mean by that is it is not just about replacing forms of money in financial transactions. What it is about is replacing the concept of networks, generally. And that is why we now have distributed companies competing with Amazon and Microsoft for cloud computing. It is why we have distributed companies competing with Google as a way of accessing search out there. There are now real companies with billions and billions of dollars of market cap built on top of these things.

But at the end of the day, what it is about is a set of decentralized technologies, starting with bitcoin, that allow people to borrow and lend without the bank credit officer potentially telling them no, but allowing an algorithm to allocate credit, so allowing people to find information without Twitter or Google deciding which information you should be allowed to read. It is about a series of things that we do every day without the intermediary of a bank CEO, a Big Tech CEO, or somebody else deciding for you. That is, ultimately, why crypto has achieved the market cap that it has, because decentralized systems are safer, they are fairer, they are more secure, and ultimately more valuable than a centralized set of internet applications.

*Ms. Kuster. So now, in June of last year China banned all cryptocurrency trade transactions and mining, and since then the United States has seen its global share of

cryptocurrency mining grow substantially.

Mr. Belizaire, in your view, what has drawn mining companies to the United States following the ban in China?

And when you are deciding where to site a new crypto mining facility, what is it you are looking for?

*Mr. Belizaire. Thanks for the question, Congresswoman. The China -- the Great China unplugging, as it has been called, has certainly seen a large increase of participants joining the U.S. market. And when they land here, they are looking for a few things.

Number one is, obviously, cheap energy. Their entire ethos has shifted from sort of cheap, wherever they can get it, to more green. So that is very encouraging.

They also look for opportunities to build very large-scaled operations. And so local markets for talent, resources, access to, you know, economic development, support, those sort of things are part of their criteria.

And the other thing they look to participate is in the general ecosystem of the marketplace, everything from support services, insurance, business operations, technology, people, finance.

And so what is exciting is the fact that the industries moving here is going to drive more maturity, because here we have rule of law, we have infrastructure, things that really drive businesses to operate properly. And for me, that is

quite exciting, because that means that the entire industry will mature into a global infrastructure platform to support some of the opportunities that Mr. Brooks mentioned earlier.

*Ms. Kuster. Well, thank you. And my time is up. I will yield back to the chair.

*Ms. DeGette. I thank the gentlelady. The chair now recognizes Mr. Dunn for five minutes.

*Mr. Dunn. Thank you very much, Madam Chair. I am glad this committee is taking up this important topic, which is on the forefront of American technological innovation.

You know, blockchain and distributed ledger technology is transforming the way we do business throughout the world, and allowing people to deploy their personal capital in new ways. In fact, my own campaign now takes donations in digital currency.

So beginning with the original cryptocurrency, bitcoin, the last 13 years has seen the rise of a lot of new applications for this distributed ledger technology, like decentralized finance, nonfungible tokens, and distributed autonomous organizations. And I think we are just looking at the beginning of this, the very tip of the iceberg, so to speak.

And we in Congress have a duty, especially on this committee, to have -- to a thoughtful approach to the technology. We need to understand it and, importantly,

ensure that new laws, new regulations are done right, implemented well, and don't strangle the innovation in this promising new technology for Americans.

Congress also should not be in the business of picking winners and losers. We should remain partial when discussing different consensus mechanisms, whether it is proof of work or proof of stake or others. It is not accurate to say at the present time that one is simply better than the other. We let the market decide those things.

Finally, we need to recognize, in order to win the future, we have to produce significantly more energy in the United States, period. And instead of running from technologies that use a lot of power, we should invest in clean and reliable power, like nuclear power and natural gas, so that we can meet that demand.

Mr. Brooks, energy generation in the United States has increased dramatically to meet a growing economy. We are going to need to continue that growth to remain competitive on the world stage. However, bitcoin has some features built into this protocol which actually -- like the halving cycle -- which seems to help it reach an energy equilibrium. The next halving is, I think, in 2024.

Can you elaborate on that point some for us, so that we understand that miners that are less efficient, that spend more on their energy, you know, they are not going to be

successful in the long run?

*Mr. Brooks. Well, Mr. Dunn, that is a very insightful comment. And people who work in the mining space look at the halving as the sign of sort of the next value increase in crypto. And so what happens around every halving is the compute network difficulty necessary to find the next bitcoin goes up, which means that the value of the next bitcoin goes up, but only the most efficient miners can survive.

So one of the positive incentives that I outlined in my written testimony about bitcoin mining in general is the incentive it creates to find more and more energy efficient ways of doing that activity, which, by the way, have massive spillover effects to other sectors outside of crypto. I point to immersion cooling, for example, as something that reduces an enormous amount of energy cost, first in bitcoin mining, but now in high-performance computing data centers globally, which we wouldn't have but for the halving incentive you talk about.

*Mr. Dunn. Yes, I would ask -- make you tell me more about that some time, but let's move on.

On that efficiency note, we are seeing much more interest in producing ultra-low voltage ASIC chips and whatnot. What are you seeing in that area?

*Mr. Brooks. Well, so we have been creating ASIC chips at BitFury since 2013. We are on our eighth generation of

ASIC chip this year. The energy improvement from 2013 to 2022 at BitFury alone is -- wait for it -- 6,100 percent. And the pioneering of those kinds of quantum leap order of magnitude efficiency gains are shared across all of computing, so not just on bitcoin mining. It is true that our ASIC chips are specialized for that, but we have now spun up an AI chip business based on some of those same learnings.

So what I would say is, in the same way the space program created lots of benefits for other things in the world, bitcoin mining has produced a lot of other fundamental innovations for other parts of the world --

*Mr. Dunn. So we spend a lot of time whining about we can't get enough chips. You are helping us with this.

*Mr. Brooks. We are on the demand side, that is for sure.

*Mr. Dunn. Excellent, excellent. So is it accurate to say that the energy used to mine bitcoin – any of these things -- in the United States, that energy is produced in a way that is cleaner than it was when it was -- the mining was being done in China, Kazakhstan, Russia?

So my view is, I think -- and I want you to tell me -- if the goal was to clean up cryptocurrency mining, energy, the best thing you can do is move it to the United States.

*Mr. Brooks. Well, no question about that. We are twice as efficient as even the U.S. electric grid, let alone

the Kazakhstan grid.

*Mr. Dunn. Kazakhstan, right.

Well, I see my time is up, Madam Chair. I appreciate the witnesses and their expertise. It is a fascinating area. Thank you so much.

*Ms. DeGette. Thank you so much. The chair now is pleased to recognize Ms. Schakowsky for five minutes.

*Ms. Schakowsky. Thank you. I want to thank this very expert all-male panel. I don't want to be snarky, but I do want to say I hope that there are some women involved in this emerging technology, as well.

I wanted to really focus on the use of fossil fuels. I know, as the chair of this subcommittee had mentioned her opening statement, that crypto miners have restarted dormant coal plants in Pennsylvania, and kept open a coal plant that was scheduled to be closed in Montana. So I think this isn't just bad for the climate, but it also really affects these fenceline communities in -- you know, where these fossil fuel plants are located.

I wanted to ask Mr. -- I wanted to focus on what Mr. Wright said in his testimony, and ask a question. He talked about the economics that may actually push crypto miners toward fossil fuel resources in the short term.

And I wondered if you could explain that a little bit more, Mr. Wright.

*Mr. Wright. Sure. I think that there is cost and there is value in electric markets. And the cost of resources, particularly renewable resources, has been coming down substantially, but the value has been increasing because we have more clean energy legislation, particularly on the West Coast. We have very high and very aggressive standards for achieving clean energy. And because of that, there is more clean energy that is needed in the market, so the demand is going up. And as the demand goes up, the price goes up, the value goes up.

Similarly, with respect to coal, I can just speak to, for example, in Washington State, we have said that by 2025 no coal can be used to serve load in this state. So what that means is there is a smaller market for that product, and it is simple supply and demand. It tends to drive down the value of the product then.

[Audio malfunction.]

*Ms. Schakowsky. -- transition to U.S. -- the electric grid toward cleaner generation, cleaner sources.

So I -- but I have to tell you that I remain somewhat skeptical and concerned that some crypto mining may still be incentivized toward using fossil fuels. And so I wanted to ask you why you have confidence that your model to increase renewables is actually scalable and is available.

[Pause.]

*Ms. Schakowsky. Mr. Belizaire, are you there?

*Mr. Belizaire. I am sorry, Congresswoman, I -- the part where you actually referenced me. But I did hear your question, and allow me to respond.

The industry is evolving, as I said. It is maturing very quickly, and it is becoming more of an enterprise operation backed by institutional capital, the same capital that backs some of the largest companies in this country. And that capital comes with very clear objectives.

The mandate is to grow in scale and build a business that can participate in this very fast-growing ecosystem. But it also is clear that the same ESG requirements that are placed on other companies are placed on these companies, as well, when that capital is placed there.

And so, as these companies go to market and look for operations, they are going to be more focused on a zero-carbon or carbon-negative footprint. The -- your question about scale, the opportunity to scale using the model we talked about is driven by two things.

Number one, there is infinite amounts of capital being invested in building more green power in the world. In the United States alone you are seeing hundreds of billions of dollars being deployed in different markets to help to drive the new RPS standards, or clean energy standards, if you will, in these different locations. And that creates lots of

opportunity for combining those new resources with these new computing capabilities to help the grid absorb more of that green energy. And I think that is what is going to drive the scale and maturity of these types of applications.

*Ms. Schakowsky. Let's hope that your vision of -- that it will be cleaner, rather than just increased fossil fuels, comes true, sooner rather than later.

Thank you, and I yield back.

*Ms. DeGette. I thank the gentlelady. The chair now recognizes the ranking member, Mr. Griffith, for five minutes.

*Mr. Griffith. Thank you very much, Madam Chair.

Mr. Brooks, I am going to do a little home cooking here, and go out -- go off of our topic, while staying on our topic. So help me out.

I represent Southwest Virginia. Southwest Virginia has a long history of mining. And lately we have been working in recent years to redevelop our abandoned coal mines for other purposes. Many of the idle mines in my district, coal and limestone, predominantly, are deep underground, they have water that is 50 degrees, the air temperature is in the fifties, an attractive natural coolant for large, hot computer systems like data centers and mining of cryptocurrency. Would you agree?

*Mr. Brooks. In my legal career, Leader Griffith, I

would have said, "Objection, leading.'' Of course, I agree.

*Mr. Griffith. That is what I love about this committee, I get to lead.

[Laughter.]

*Mr. Brooks. Listen, bitcoin miners are always looking for lower temperature. I mean, a big part of the energy input is cooling costs. That is one of the reasons why Iceland, Canada, and places like that are very attractive sites.

*Mr. Griffith. So you would say that we have a real asset in Southwest Virginia if we are trying to repurpose from -- what we always hear from my colleague, who just mentioned reducing coal and so forth -- we are trying to repurpose our industry. It was predominantly, in a number of my counties, the number-one industry. This would be a good way for a win-win, both environmentally and for cryptocurrency, wouldn't you agree?

*Mr. Brooks. It sounds like we should talk after the hearing.

*Mr. Griffith. I think we should. I do appreciate that.

Mr. Zerzan and/or Mr. Wright, can you see potential in looking at abandoned mines for cryptocurrency mining purposes?

We will go with you first, Mr. Zerzan.

*Mr. Zerzan. Yes, sir, absolutely. I think you heard it from someone who knows.

*Mr. Griffith. Yes.

Mr. Wright?

*Mr. Wright. I think it is clear that cryptocurrency miners are looking for a lowest-cost resource, and so, from what I know about that, I think it would be a low-cost resource.

*Mr. Griffith. I think that is great.

Mr. Brooks, in 2021, 35 bills here in Congress focused on cryptocurrency and blockchain policy. This begs the question of whether we are rushing to over-regulate an industry out of existence. What type of barriers would hurt the mining industry?

And again, I am talking about crypto mining, not coal mining in this case. What kind -- what would hurt the industry the most, the mining industry the most?

*Mr. Brooks. Well, so Mr. Griffith, I -- several different things, I think, would be bad.

So the first thing would be an outright price discrimination against bitcoin mining, right? Markets decide what the most valuable use of a megawatt of electricity is, not wise politicians, not bank CEOs, not other people. So if crypto has produced $3 trillion of value, it is not up to any of us to decide if that was rational. That is what large

numbers of people spending their own money decided. So if we decided to charge bitcoin miners more than we charge video gamers, or more than we charge retail users of electricity, that is putting our thumb on the scale of markets. So that would be bad.

It would also be bad to assume that the entire value of bitcoin, for example, is measured just by the market cap of bitcoin. Because, in fact, the transaction throughput on the bitcoin blockchain is many, many times -- many multiples of the bitcoin market cap. And that is because the network that is bitcoin has all kinds of transaction layers built on top of it, the Lightning Network being the most famous. That is transacting hundreds of billions of dollars of transactions every day using the Bitcoin blockchain. And so thinking that the cost benefit that this committee thinks about is limited to the market cap would be a big mistake. So that would be a problem.

And finally, although a little bit more of a Financial Services Committee than an Energy and Commerce Committee issue, bitcoin is the reference asset for most decentralized finance. So if you want to go and get eight percent at BlockFi, or four percent at Genesis or someplace else, the way that rate of return is being generated is because of bitcoin trading going on in the background. So if bitcoin, as the bedrock of the entire crypto ecosystem went away, a

lot of the rest of these Web3 innovations would also go away. So failing to recognize that connection would be a problem.

*Mr. Griffith. I appreciate that.

Mr. Zerzan, I have got limited time, but I am going to try to zing this one in here if I can.

It has been interesting, as I have read, there is a lot of articles that said that China went away from cryptocurrency, except their own crypto that they are putting out, because of energy issues. But it seems like, to me, they don't like, as Mr. Brooks just said, decentralized finances. It seems to me that that might have also been a big reason that China wants to control everything within the Chinese borders, and perhaps elsewhere in the world, and they don't like the idea of some upstarts who are decentralized, who like the idea of the free market. What do you think?

*Mr. Zerzan. Crypto --

*Mr. Griffith. Mike.

*Mr. Zerzan. I don't want to be hyperbolic, but crypto equals freedom, and there are a lot of places in the world that don't like freedom.

*Mr. Griffith. And I can say, and one of those might be China.

I yield back, Madam Chair.

*Ms. DeGette. Thank you. The chair now recognizes Mr. Tonko for five minutes.

*Mr. Tonko. Thank you, Madam Chair.

My home state of New York has seen a lot of crypto mining due to access to cheap electricity and other factors that make New York attractive. Some of these are focused on clean hydroelectric power, but we have also seen some restarting of retired fossil fuel plants.

So Mr. Belizaire, in your testimony you identified the need to separate bad actors from the rest of the industry, and to encourage the shift to only using clean energy. How do you suggest we do that?

*Mr. Belizaire. Well, one idea would be to take a page out of the clean energy industry, and the legislation around perhaps creating certain tax credits or financial incentives for companies to support clean energy development through the use of developing these new flexible load environments.

The other would be to encourage the grid operators throughout the country to expand their definitions of demand response solutions to include these types of new computing platforms that can be added to the grid, and thereby earn additional revenue that would offset the volatility of cryptos, which would restructure the business model of these businesses, and allow them to grow and expand and reduce their cost of capital over time.

And then the third idea would be to encourage renewable energy developers to consider combining their new resources

that they are standing up with these new types of facilities, structuring finance around the combination of those two units, and creating a combined unit that can be added to the grid. We fundamentally believe that this approach, this vertical integration, could be the foundation for accelerating the amount of renewables on our grid, and getting us closer to our visions of the transition that we are currently under.

*Mr. Tonko. Thank you so much.

And Mr. Juels, your testimony acknowledges that consuming excess electricity from renewables is -- and I quote -- "certainly more desirable than use of less sustainable alternatives.''

However, you also talk about some of the opportunity costs of this approach. So can you expand on those opportunity costs, please?

*Mr. Juels. Well, I am not an energy expert. I can mention a few. There are various forms of high-performance computing, such as drug discovery. One could smelt bauxite, for instance, an energy intensive operation.

But if you don't mind, Congressman, actually, I would like to correct the record with respect to a claim that was made earlier that I think is quite relevant to this point. It was noted earlier that mining machines are becoming more energy efficient, and that is absolutely the case, but also

an extremely deceptive claim, in my view. Mining rigs are not like the light bulbs in our house, where efficiency means -- more efficiency means less electricity used.

So to be clear, individual mining rigs are growing more energy efficient, but crypto mining as a whole is becoming less energy efficient. And that is because rewards and, therefore, profits aren't determined by absolute mining power, but by mining power relative to your competitors.

So mining rigs have grown more energy efficient over time, and one can see this with reference to the data. But overall energy consumption in crypto mining has been growing over time, particularly over the past year.

So, in short, more efficient mining equipment does not mean a more efficient bitcoin network. And I apologize for not answering your question at greater length, but I did want to make that point. Thank you.

*Mr. Tonko. Thank you. Why do you believe there are still better ways to be using this excess energy?

*Mr. Juels. Because, as I mentioned earlier, proof of work is unnecessary for the maintenance of blockchains. Proof of stake is a perfectly viable alternative that is already securing hundreds of billions of dollars in value.

So earlier it was claimed that proof of stake is not as secure as proof of work because of a largely theoretical concern about proof of work validators, as they are called,

being able to wipe the blockchain clean. But as I said, that is a theoretical concern. It makes certain suppositions that are not plausible, in my technical view.

And additionally, in practice, it has not proven significant.

So, as I said, we have a viable alternative that uses -- essentially, the amount of energy for a large network that would be required would be that comparable to a small village, rather than an entire nation. So in that sense, there are better uses for the energy that is being poured into the bitcoin network. We can redirect it to almost anything else if we shift the energy sources being used to maintain blockchains today to something that consumes a negligible amount of energy.

*Mr. Tonko. Thank you very much.

I also had a question for you, Mr. Wright, but I see I am out of time, so we will get that to the committee to get to you.

[The information follows:]

**********COMMITTEE INSERT**********

*Mr. Tonko. And with that, Madam Chair, I thank you and yield back.

*Ms. DeGette. Thank you so much.

Mr. Griffith, do you have anyone on your side of the aisle who is --

[Audio malfunction.]

*Mr. Griffith. No, ma'am, I do not at this time.

*Ms. DeGette. Okay. In that case, we are going to go to you, Mr. Peters. You are recognized for five minutes.

*Mr. Peters. Thank you, Madam Chair. Thanks for the hearing today. It has been really illuminating.

Obviously, there is real concerns about energy and carbon intensity of the proof of work blockchains. It is possible that the crypto mining industry can serve as a potential source of innovation because of the volume of energy that they are using. Bitcoin mining demands specialized, powerful computing hardware, and we have been discussing that this hardware requires a lot of power to function.

I am interested in the developments around efficiency. I want to get to the comment that Mr. Juels made, but I want to start with Mr. Brooks.

Can you tell me what developments there have been, in terms of computing efficiency, that could reduce power consumption? How does that work?

*Mr. Brooks. Sure. Well, so thank you very much, Congressman, for the question.

So the first thing is that in every generation of equipment -- and when I say equipment here, I am really talking about specialized ASIC chips in order to make bitcoin profitable at all. So if we were still running the chips from three generations ago, say from, you know, five, six, seven years ago, the profitability of the activity would be far less than it is with much more efficient chips.

So, you know, sort of to speak to the point that was made a moment ago by my fellow panelist, the idea that somehow the system is less efficient, even though the chips are more efficient, sort of doesn't make sense. The system may use more energy. That is a feature of the bitcoin blockchain, for good reasons that I outline in my written testimony. But the system is clearly more efficient in that it is consuming less energy per -- you know, it is -- X joules per terahash is sort of the measure. And we are hundreds, even thousands of percent more efficient than that.

The point I was making earlier, though, is other parts of the economy benefit from those fundamental innovations. So bitcoin mining is not the only place that low-voltage ASIC design is used, nor is immersion cooling only used in bitcoin mining. And yet, because of the economic incentives created by bitcoin mining, those energy-saving innovations were

developed, and are now being used in other parts of the economy.

So my point is that we learn about energy efficiency in a relatively energy-intensive space like bitcoin mining, and then the broader economy benefits from that as those knock-on effects are felt elsewhere.

*Mr. Peters. Right.

Mr. Juels, let me come back to you, because I was going to draw -- I was going to come back to the distinction that you drew between efficiency of the units and the network as a whole. I didn't understand, because it seems to me what Mr. Brooks said was right, that if you have units that are more efficient, they would aggregate to a more efficient network. I thought the point you were making was that the networks --

[Audio malfunction.]

*Mr. Peters. -- gotten so much bigger that the amount of energy that we are using is not reduced. Am I --

[Audio malfunction.]

*Mr. Juels. So the point was made earlier that the network is becoming more efficient in terms of the amount of energy needed per terahash, for instance.

*Mr. Peters. Right.

*Mr. Juels. But end users don't care about terahashes. End users care about the number of transactions the system is processing. And the number of transactions that the bitcoin

network is processing has remained fairly steady over its lifetime, about five transactions a second, which is relatively minuscule for a global payment processing network.

The amount of energy consumed by the bitcoin network as a whole has grown over time. So the amount of energy that this system, which is performing five transactions a second, has been consuming has grown over time. And in that sense, it is less efficient. There is more energy per transaction being consumed by the network now than there was, for instance, a year ago.

Now reference was made to, for instance, the Lightning Network, which is a second layer of technology that, in principle, can increase the transaction rate of the bitcoin network. But it is really in its infancy, and it remains to be seen how successful it is, and it is not used by a terribly large fraction of end users at this point.

I hope that answers your question.

*Mr. Peters. I think so. You are doing -- sort of using a different denominator, it sounds like.

Mr. Belizaire, so talk a little bit more about the advancements you think that bitcoin mining industry can make, compared to other type of batchable computing you have referenced. How else would this be -- how would you extend this out?

*Mr. Belizaire. Well, the way to think about it is, if

the vision I have been laying out here at the hearing comes to fruition, you will have lots of these types of flexible data centers around the grid. And as they get to a certain size, they won't only have bitcoin mining in them, they will have other types of pausable, batchable applications, like applications that help to decide the next movie to display to anyone on this meeting, or helping to see if a molecule is a good fit for addressing this pandemic that we are working on. Those types of back-end analysis processes can be done within these facilities, once they are established and have the scale to address these types of applications.

That is the hope that we have, that as you begin to make these -- this infrastructure and computing a integrated part of the grid, it can play many, many roles, that type of computing, to solve a host of problems, not just securing the bitcoin network.

*Mr. Peters. Thank you, sir. I am out of time, but, obviously, this is an important consideration. This is going to only draw more energy over time in aggregate, and it will be a challenge for our committee.

So thank you, Madam Chair, I yield back.

*Ms. DeGette. I thank the gentleman. The chair now recognizes Ms. Schrier for five minutes.

*Ms. Schrier. Thank you, Madam Chair, and thank you to our witnesses.

Low-cost, clean energy drew cryptocurrency companies around the world to Chelan and Douglas Counties. And over the last 10 years, cryptocurrency companies have increased their demand for energy, and at times this can threaten the available energy for homes and businesses in the region.

And Chelan and Douglas Counties took different approaches when working to balance the cryptocurrency needs with community reliability needs, and also to cover these increased costs, overhead costs, and the risk that these companies could pick up and leave at any time because they are so portable. Douglas County has a policy that increases rates by 10 percent every 6 months. Chelan County implemented a different policy.

Mr. Wright, can you give a quick summary of Chelan County's approach to pricing?

*Mr. Wright. Yes, we -- what we did was address the problem associated with portability. That is really the fundamental issue here, the ability for cryptocurrency miners to move on short notice.

So the exposure for a local community is that you will build assets, transmission distribution, generation, and that they will become stranded. And in our case, that would mean that the local customers, the people who live in Chelan County, would bear that cost.

So our rates were modified to put in place an upfront

charge for transmission and distribution, so that it wouldn't be exposed to that stranded asset risk; and for generation, that we would price based on short-term market prices, recognizing that we wouldn't be making a commitment to a long-term purchase, or to devoting some of our existing resources to that load, but instead would be able to take advantage of short-term markets. And the net effect of that is it neutralizes the impact to existing customers.

*Ms. Schrier. Thank you. That makes sense.

Another question. At the end of your testimony you posed this question about whether cryptocurrency's value to society is sufficient for a community to want mining operations in their area. And you said that the whole idea left the community of Chelan mostly perplexed.

Clean energy is a limited resource, which makes me think about how we make decisions about how to responsibly use that energy. We heard that China banned cryptocurrency, in part because of the energy demand. We know cryptocurrency is used for nefarious purposes, like drug trafficking and ransomware, and that has become kind of a get-rich-quick investment for some.

Do you have your own personal answer about cryptocurrency's value, and whether it is sufficient to warrant the tremendous energy demands?

*Mr. Wright. I think it depends, to be honest with you.

It depends on how the industry evolves.

So certainly there are lots of questions about how the regulatory regime is going to change. There -- the whole question about nefarious purposes certainly seems to be teed up at the national level right now. I think folks in Chelan County were looking for some guidance about how is this stuff being used, and is someone watching it to make sure it is not being used for the wrong thing. So that part is important.

Second, there is this efficiency question. The -- in the electric utility industry, you know, we will pay a business to become more efficient. We would prefer that it is more efficient from the beginning. It is much cheaper to implement efficiency if you do it at the beginning, than trying to do a retrofit.

*Ms. Schrier. That makes –

*Mr. Wright. So that is another question that, I think, gets addressed there.

*Ms. Schrier. And one more quick question, just speaking to efficiency and a limited resource. I wanted to touch back on that.

Right now we export hundreds of millions of dollars worth of energy to Canada each year as part of the Columbia River Treaty, in exchange for a long-ago completed dam and flood management. And at a committee markup just a few months ago, a bipartisan group of this committee, including

myself and Ranking Member McMorris Rodgers, expressed concern about the lack of progress in the renegotiation of the Columbia River Treaty with Canada.

In order to ensure that we can meet demand for clean electricity in Washington State, is there something this committee can do to accelerate the Columbia River Treaty renegotiation process?

*Mr. Wright. Well, boy, I think yes. It would definitely help if the committee expressed to the Administration the importance of using mechanisms that are defined in the treaty that could repatriate a coal plant's worth of electricity that could support carbon emission reduction, reliability, load growth, and maintain affordability for Northwest consumers. And I think we could address the flood control and ecosystem issues at the same time that are out there. So yes, I think it would help.

*Ms. Schrier. Thank you very much, Mr. Wright. Steve, I am thrilled that you joined us today.

I yield back the rest of my time.

*Mr. Wright. Thank you.

*Ms. DeGette. I thank the gentlelady. The chair now recognizes Mrs. Trahan for five minutes.

*Mrs. Trahan. Chairwoman DeGette and Ranking Member Griffith, thank you for convening this important meeting, and thank you to the witnesses for offering your expertise on

cryptocurrencies and their environmental impact.

A key underpinning of blockchain technology, generally, is the decentralized nature of the network. And in cryptocurrencies, the security and accuracy of transactions is achieved through this decentralization. However, the bitcoin mining industry has become increasingly consolidated. Estimates have suggested that as few as 50 bitcoin miners control half of the mining capacity, globally.

My first question is for you, Mr. Brooks. What are the implications for the bitcoin network if fewer players control an increasing amount of the mining activity?

*Mr. Brooks. Well, thank you, Congresswoman, for that question.

One of the distinctions between the bitcoin blockchain and proof of stake networks is it matters less, in the proof of work context, the number of miners that exist, because it is not as though the miners can simply collude and choose to alter the bitcoin blockchain the way that you could on a proof of stake blockchain. In a proof of work system, you are receiving bitcoin rewards randomly, right, because there is a lottery going on. And I think this is one of the most confusing and perhaps most misunderstood aspects of bitcoin.

What goes on is not that there is a correct answer about validating all of the transactions on the blockchain and some miner is figuring out the correct answer. What happens is

there is a puzzle that has no correlation at all to the underlying transactions, and whoever gets the right answer first is part of a lottery ticket winner who gets that reward. That is how it is different.

So I can't collude with Riot and Marathon and the other biggest miners, and decide to alter the blockchain. I could do that, however, on a proof of stake network, just like I could in corporate America. I could be a corporate raider, and round up a majority of the shares, and take over the company, and oppress the minority shareholders. That is why proof of work -- one of the reasons why proof of work is a good thing, because it prevents that.

*Mrs. Trahan. Yes. So Professor Juels, your work in the field of computer science helps underpin the proof of work blockchains that we see today. But you are a proponent of alternative methods such as proof of stake. And one of the major criticisms often levied at proof of stake networks is around the issue of consolidation.

So Professor Juels, is there a consensus in academia or in industry around the viability of proof of stake as an alternative to proof of work-based mining? And if not, why not?

*Mr. Juels. Excellent question. The question of trust in stakeholders and the degree of centralization in a blockchain isn't mainly a function of whether proof of work

or proof of stake is used. It is a question of the dynamics of the network.

Centralization is a systemic problem. It is affecting, essentially, all blockchains today, and it is something the industry is working to reduce. The claim that proof of work somehow provides protection against centralization simply isn't correct. And the claim that proof of stake miners can somehow manipulate the system more effectively than proof of work relies, as I mentioned earlier, on a theoretical consideration that really hasn't proven to be of importance in practice.

There are concerns about the rich getting richer in proof of stake systems, but this too is a systemic problem. A study recently by faculty at MIT and the London School of Economics showed, for instance, that .01 percent of the wallets in bitcoin controlled 27 percent of the Bitcoin. So bitcoin isn't an egalitarian system.

Bitcoin is not the worst blockchain in this respect. Bitcoin is a wonderful technology, and it -- you know, I have the greatest respect for its creators and for that community. But there are systemic problems that have nothing to do with whether proof of work or proof of stake is used.

Proof of stake is a viable technology. As I mentioned, it has proven its viability in securing hundreds of billions of dollars of value in a very adversarial environment, by

which I mean that if somebody can hack proof of stake, or could have hacked proof of stake, that person or entity could have made a lot of money. But that hasn't happened, and that is testimony to the robustness of proof of stake.

Proof of work is equally robust, but, unfortunately, consumes an enormous amount of electricity.

*Mrs. Trahan. So a common criticism of proof of stake, which Mr. Brooks has already made, is that it is less secure, primarily due to some of these consolidation issues. So Professor Juels, do proof of stake networks pose security concerns if their mining industries become more consolidated?

*Mr. Juels. Any blockchain that becomes centralized, whether it is proof of work or proof of stake system, poses a threat to the security of the system in that the miners can, in principle, take over the system.

Today the bitcoin blockchain can, in principle, be controlled by a set of four entities. They are known as mining pools. If they collaborate, they can, in principle, spend the same coins twice, or cause the network to simply stop processing transactions. So the idea that proof of stake protects against this problem is simply not true. And in fact, there have been proof of work -- sorry, that proof of work protects against this problem is simply not true.

There have been proof of work systems -- the Ethereum Classic is one example; Bitcoin Gold, a bitcoin spin-off, is

another -- that have been successfully attacked by people who rented hash power, and took over the network by devoting more resources to the network than the other miners there. So again, proof of work does not provide definitive or inherent protection against centralization, and we have seen that in practice.

Proof of stake, as I said, does raise some concerns about the rich getting richer. But that is not really a function of the use of proof of stake. There are scientific papers suggesting that is really a question of how the system is calibrated or parameterized.

*Mrs. Trahan. Thank you.

And thank you, Madam Chair, for giving me that extra time.

*Ms. DeGette. Thank you. We are all learning here. The chair now recognizes Mr. O'Halleran for five minutes.

*Mr. O'Halleran. Thank you, Madam Chair and Ranking Member, for this meeting.

I guess what concerns me right now -- and I am going to get off it right away -- is I have heard of manipulate, raised concerns, threats, multiple other issues like that during the course of this. So based on my experience with financial markets, I go back to one of the issues that was brought up earlier, and that is the entire rule of law, and how we address these types of issues later on in other

discussions. But it is obvious that there is a lot more to be discussed.

One argument we hear from the crypto mining industry is that -- is facilities and energy consumption are no different than the data centers and energy consumption of web service and cloud providers. From the outside, crypto mining facilities and data centers such as those used to transmit the data for today's hearing have some common characteristics, but they also differ in some ways that are important to understand as we consider their impact on communities.

Understanding the impact that the crypto mining companies on electrical -- the electrical grid is absolutely critical to the hearing, and is a subject that deserves more attention than we are able to give it today.

Mr. Wright, as a grind operator, you served both traditional data centers and mining operations. From the perspective of a utility, can you briefly describe the difference between a crypto mining facility and a data center as large consumers of energy?

*Mr. Wright. Thank you for the question. I will tell you that that was one of the issues that we wrestled with for quite a while, and it is very difficult to tell, because from the outside you don't really know what is going on inside the warehouse that has the crypto serving machines.

What we have found is that, at least initially, there was a pretty big difference in the business models between the companies. We found that the companies that were going into the data-serving space were the big companies, and they were highly creditworthy, and they were more willing to engage the conversations around how do we match up our business with the electric utility industry.

I want to say Mr. Belizaire has laid out a really important vision for this industry. And to the extent that it could be achieved, there is a tremendous value that could come to the electric utility industry and electric consumers. We didn't find that from the folks who came to town, to be honest. We just did not see people who were prepared to engage in that kind of conversation. Whereas, with the large data server farms, candidly, the big companies, the Microsoft, the Googles, et cetera, they were just more sophisticated in their approach, and were willing to try to understand what the impact would be on local utility systems and local customers.

*Mr. O'Halleran. So, thank you. I was interested in the one statement you made, from the outside you don't know what is going on inside -- problematic to me, and then raises concerns is one of the things you mentioned.

Mr. Belizaire, can you describe the kinds of jobs that your facilities create at the facility, and the type of

construction jobs?

Because we went from the growth factor -- I heard 300-and-some-odd percent. From what was the baseline of that number to 300-and-some percent of additional employees? Is that on a constant basis? Is that on a construction basis? What is that number, and how was it -- did it come to be?

*Mr. Belizaire. Well, Congressman, I can't speak to the growth in the number, and what the baseline was here. But what I can speak to is the type of jobs that exist within these facilities and as the industry grows.

By way of a sense of magnitude, approximately $5 billion has been invested in publicly-traded mining companies and data center companies like the company that I run.

*Mr. O'Halleran. Excuse me. I would like to go back to the statement of 300-and-some percent increase in jobs. Is there a 300 --

*Mr. Belizaire. Yes, sir.

*Mr. O'Halleran. -- percent increase in jobs?

I understand the financial issues, they are large. But I want to know how many jobs --

*Mr. Belizaire. Yes, I --

*Mr. O'Halleran. -- are being produced for the amount of energy that is being used in this process.

*Mr. Belizaire. Yes, I was getting to that. I can't speak, as I said, as to whether there was that much of an

increase. I can have my team look into the specifics and send it to you. But what I can tell you is about our world.

Because there is that much capital, we are developing facilities that are quite large, and they require very highly-skilled individuals and employees to run those facilities. So in our facilities we hire data technicians. In fact, in our company, we specifically look to hire veterans in those roles, because we think it is so important. They have certain skills that they have acquired within their roles in the military that are applicable here. We put them through training programs, and they become permanent players in the operations and management of these facilities --

*Mr. O'Halleran. My time is up.

And thank you, Madam Chair, and a lot more work to do.

*Ms. DeGette. I thank the gentleman, and I really want to thank all of the witnesses.

There is a reason why this committee is called the Oversight and Investigations Subcommittee, because we really are investigating what the impacts are of blockchain technology, of cryptocurrency. And we have learned a lot today from all of our wonderful witnesses, different perspectives.

But ultimately, the Energy and Commerce Committee, we are trying to look at how we can transition to clean renewable energy over time. And as this technology

increases, it is obvious -- and as more of these companies locate to the United States, this is going to be an increasing issue for us to discuss in our committee.

Obviously, we don't have any answers. That is not what this investigation is about. But all of you have helped us immeasurably in our understanding of the industry, of the economics, and of the energy demands. So I want to thank all of you.

I also want to remind members that, pursuant to committee rules, you have 10 days, business days, to submit additional questions for the record to be answered by the witnesses --

*Mr. Soto. Madam Chair?

*Ms. DeGette. -- who have appeared before the subcommittee. And I want to ask the witnesses to respond promptly to any of the questions, if you receive any.

I also would like to insert into the record by unanimous consent the revised written testimony of Brian Brooks, the CEO of BitFury, and --

[Audio malfunction.]

*Ms. DeGette. -- alluded to these revised remarks, and also, an op ed by Matt Stoller dated December 2nd, 2021, offered by Ms. Schakowsky.

[The information follows:]

**********COMMITTEE INSERT**********

*Mr. Soto. Madam Chair?

*Ms. DeGette. Oh, wait, wait, wait. Breaking news. Mr. Soto has just appeared, and he would like to waive on to the committee.

Good thing we didn't gavel it down yet, Mr. Soto. I am going to recognize you for five minutes.

And thanks to everybody for your patience.

*Mr. Soto. Thank you, Madam Chair, and also Mr. Griffiths, for your patience.

I am honored to be one of the co-chairs of the Blockchain Caucus here in the Congress. And look, we have to recognize this stuff is mystifying to most Americans. A fictional founder, Satoshi Nakamoto, you solve puzzles to get bitcoin and Ethereum. It is an intriguing way to get the currency out there, but it also really confuses a lot of people.

We have been very supportive for years, because I believe this is going to be key to international transactions, making them more efficient, particularly when you are providing services across the nation, like a travel agent in Central Florida, in Orlando, where I represent, or remittances, for instance, where it will be far more efficient. It also makes the internet transactions more secure.

So we know we have to establish rules of the road, both

statutory, for jurisdiction between the regulatory agencies, and the definitions for each asset, because cryptocurrency can be a currency, it could be a future, it could be a commodity, and it could be sometimes a security.

So this committee is the first one to actually pass blockchain cryptocurrency bills out of the House, two of my bills to at least get the ball rolling with Department of Commerce and the FTC to give us reports so we could finally get to the key of establishing these definitions and jurisdiction.

Taxation rules have already begun through the bipartisan infrastructure framework, although there are some reforms that need to happen to those to make it more clear.

We also need to ensure that cryptocurrency doesn't become the preferred currency of cyber terrorists. We saw that with the Colonial Pipeline.

And also the ability of the United States to claw back some of that money.

This energy part, though, is really puzzling, because energy use is significant. I just read about a coal plant purchased and remaining open in North Dakota, simply with plans to build a data center to mine bitcoin. Strange, strange stuff.

But if cryptocurrency is going to be the currency of the future, we can't make it ironic, right? We can't have it

become another major cause of climate change in the process. That is probably not what people are thinking about as we are looking for the future of the economy.

First, Mr. Ari Juels, my understanding is you helped create the term "proof of work.'' So obviously, you have been pretty focused on this area. I want to talk a little bit about data oracles. How could data oracles help blockchain systems run more efficiently and consume less energy?

*Mr. Juels. Oh, that is a great question. That is not the primary role of what is called an oracle.

I alluded earlier to smart contracts. These are small programs that run on blockchains, and they are powering some of the most interesting innovations, things like decentralized finance and like NFTs, which, of course, have been sweeping through the media, and have had a profound cultural impact.

The thing about blockchains is that, for various technical reasons, they lack direct internet connections. It is not possible for one of these little programs, these smart contracts, to reach out and query a website the way that you or I would. The purpose of an oracle is to feed data to smart contracts so that they do have access to web data. And in essence, the role of an oracle is to connect blockchains to off-chain systems: web servers, other blockchains, and so

on and so forth. So you can think of oracles as the eyes and ears of smart contracts, or blockchains, as it were.

*Mr. Soto. Mr. Brooks, you were the acting comptroller currency. I know you worked on some innovative issues while you were in that position, and have seen this from a government perspective. What do you think are some things the government should be considering when developing ideas on how to encourage less energy-intensive efforts?

*Mr. Brooks. Well, Mr. Soto, thank you for the question, and thanks for all of your focus on this issue over the years. You are one of the real leaders in the Congress on it, and I know that you have been a huge intellectual source of support.

What I would say is it is important to let markets and price signals work. And so when I hear policymakers, whether they are bank regulators or energy regulators or Members of Congress, talk about whether this is a good use of energy, you know, in my sort of Chicago school way of thinking, the best way to allocate energy is based on where the highest value user is.

And so, you know, we have a certain energy mix on our grid. It is 24 percent coal, it is X percent solar, it is Y percent natural gas, and other kinds of things. That is for a whole set of reasons having to do with transmission costs, you know, mining costs, exploration costs, and those kinds of

things.

Bitcoin, at some level in particular, is like an energy derivative. It provides real-time price signals to the market about the most valuable use of energy in a given place. And I will tell you the way I think about it in my current role. In my current role, we virtually only deploy mining in joint ventures with utility providers or renewable providers. We don't go and buy a power plant and burn coal to support our bitcoin mining. We talk to energy utility X, wind farm Y, and we build these things with them, precisely because they can only make the economics work if there is a baseload consumer there, and that is almost always bitcoin mining.

So what I would tell you is there are interesting anecdotal stories of some small mining shop that buys a plant somewhere, and that might not be a good thing, I am not defending that at all. But the vast majority of industrial-scale bitcoin miners are the price transmission belt for all of energy, globally. And so all of our projects are "Some utility says we can't build another plant unless you will come and be our interruptible source of baseload consumption.'' That is the beauty of bitcoin mining.

*Mr. Soto. Thank you, and my time has expired.

*Ms. DeGette. Thank you. Thank you very much, and I think now everybody has asked questions.

And all of this information has been extremely helpful, so we look forward to continuing to work with all of you as we continue to develop our energy policy.

And with that, the subcommittee is adjourned.

[Whereupon, at 1:43 p.m., the subcommittee was adjourned.]