SECURING AMERICA'S FUTURE: SUPPLY CHAIN SOLUTIONS FOR A CLEAN ENERGY ECONOMY

HYBRID JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT AND CLIMATE CHANGE

OF THE

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C O N T E N T S

[1] Mr. Zindler and Mr. Switzer did not answer submitted questions for the record by the time of publications.

[2] The information has been retained in committee files and also is available at https://docs.house.gov/meetings/IF/IF18/20211116/114231/HHRG-117-IF18-20211116-SD006.pdf.

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[3] The information has been retained in committee files and also is available at https://docs.house.gov/meetings/IF/IF18/20211116/114231/HHRG-117-IF18-20211116-SD008.pdf.

[4] The information has been retained in committee files and also is available at https://docs.house.gov/meetings/IF/IF18/20211116/114231/HHRG-117-IF18-20211116-SD009.pdf.

SECURING AMERICA'S FUTURE: SUPPLY CHAIN SOLUTIONS FOR A CLEAN ENERGY ECONOMY

TUESDAY, NOVEMBER 16, 2021

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT AND CLIMATE CHANGE,
JOINT WITH THE SUBCOMMITTEE ON ENERGY,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittees met, pursuant to call, at 10:03 a.m., in the John D. Dingell Room 2123, Rayburn House Office Building, and remotely via Cisco Webex online video conferencing, Hon. Paul Tonko (chairman of the Subcommittee on Environment and Climate Change), presiding.

Members present: Representatives Tonko, DeGette, Schakowsky, Sarbanes, Clarke, Peters, Dingell, Barragán, McEachin, Blunt Rochester, Soto, O'Halleran, Pallone (ex-officio); McKinley, Johnson, Mullin, Hudson, Carter, Duncan, Palmer, Curtis, Crenshaw, and Rodgers (ex-officio). Rush, Peters, Doyle, McNerney, Tonko, Veasey, Schrier, DeGette, Butterfield, Matsui, Castor, Welch, Schrader, Kuster, Barragán, McEachin, Blunt Rochester, O'Halleran, Pallone (ex officio); Upton (Subcommittee on Energy ranking member), Burgess, Latta, McKinley (Subcommittee on Environment and the Economy ranking member), Kinzinger, Griffith, Johnson, Bucshon, Walberg, Duncan, Palmer, Pence, Armstrong, and Rodgers (ex officio).

Also present: Representative Joyce.

Staff present: Adam Fischer, Professional Staff Member; Waverly Gordon, Deputy Staff Director and General Counsel; Tiffany Guarascio, Staff Director; Perry Hamilton, Clerk; Zach Kahan, Deputy Director Outreach and Member Service; Rick Kessler, Senior Advisor and Staff Director, Energy and Environment; Mackenzie Kuhl, Press Assistant; Brendan Larkin, Policy Coordinator; Tyler O'Connor, Energy Counsel; Kaitlyn Peel, Digital Director; Tim Robinson, Chief Counsel; Nikki Roy, Policy Coordinator; Andrew Souvall, Director of Communications, Outreach, and Member Services; Medha Surampudy, Professional Staff Member; Rebecca Tomilchik, Policy Analyst;Michael Cameron, Minority Policy Analyst, Consumer Protection and Commerce, Energy, Environment; Jerry Couri, Minority Deputy Chief Counsel for Environment; Nate Hodson, Minority Staff Director; Emily King, Minority Member Services Director; Mary Martin, Minority Chief Counsel, Energy and Environment; Brandon Mooney, Minority Deputy Chief Coun-

sel for Energy; Peter Spencer, Minority Senior Professional Staff Member, Energy; and Michael Taggart, Minority Policy Director.

Mr. TONKO. The Subcommittee on Environment and Climate Change and the Subcommittee on Energy will now come to order.

Today the subcommittees are holding a hearing entitled, "Securing America's Future: Supply Chain Solutions for a Clean Energy Economy."

Due to the COVID-19 public health emergency, members can participate in today's hearing either in person or remotely, via online video conferencing.

Members, staff, and members of the press present in the hearing room must wear a mask, in accordance with the updated guidance issued by the attending physician.

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

Since members are participating from different locations at today's hearing, all recognition of members, such as for questions, will be in the order of full committee seniority.

Documents for the record can be sent to Rebecca Tomilchik at the email address where—we have provided to staff. All documents will be entered into the record at the conclusion of the hearing.

Before we get started I want to recognize that Friday was the last day for the committee's long-serving chief environmental counsel, Jackie, Jacqueline Cohen. Jackie is a tremendous public servant, and was instrumental to the development and enactment of numerous historic environmental laws, including TSCA reform, which I remember well, and reauthorization of the drinking water SRF. And hopefully, the Build Back Better Act will soon be added to that list. I want to express my gratitude for her years of service, and wish Jackie and her family the best.

We wish you well, and we are going to truly miss you, Jackie. So godspeed.

I now recognize myself for 5 minutes for an opening statement.

OPENING STATEMENT OF HON. PAUL TONKO, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

The Biden Administration and Democratic members of this committee have proposed ambitious climate targets: at least 50 percent economy-wide greenhouse gas emissions reductions from 2005 levels by the year 2030; at least half of new vehicle sales are electric by 2030; and a carbon-free electricity system by 2035; as well as the policies that will ensure these targets are met.

Achieving these goals will require serious commitments and immediate action. It will also require building an immense amount of new infrastructure and manufacturing capacity. Production of clean energy technologies, including wind turbines, solar panels, batteries, advanced vehicles, charging equipment, and electric appliances will need to be ramped up significantly. And we will need

low-emissions construction materials, like that of steel and cement, to support clean energy deployment.

The sustainable economy of the future will definitely need to be built and manufactured. The question that remains to be seen is whether it will be manufactured by Americans.

In recent years we have heard bipartisan concerns about our increasing reliance on China and other foreign competitors for clean energy technologies. This is especially true of certain critical minerals. Today, some foreign sources of lithium, cobalt, and nickel involved—involve environmentally harmful practices, and unsafe and unethical labor practices and conditions.

In order for the United States to fully seize the opportunities of the clean energy economy, we need to develop our own resilient supply chains. This may include domestic sources of critical minerals, as well as processing, manufacturing, and recycling capabilities. Ambitious climate action requires nothing less than fundamental changes to our economy and our energy system.

Any change on this scale will have its challenges. I acknowledge that. These challenges, including the need to develop domestic supply chains, are not reasons not to act, but rather, reasons to discuss how to best overcome these issues in a way that benefits America's workers and her entrepreneurs.

Members of Congress have two options: use this as an excuse to oppose our domestic energy transition, and guarantee that our foreign competitors dominate the global economy of the future; or we can do something about it. We can support Federal policies that will enable American workers to benefit from the transition, ensuring that we are researching, developing, and deploying the next generation of clean energy technologies right here, in the United States, and exporting them around the world.

This effort is already underway in Congress. Last year I worked with Congressman Curtis on a Science Committee bill to authorize a battery and critical mineral recycling research program at DoE, which was enacted in the Energy Act of 2020. These R&D efforts can make batteries more recyclable, and future breakthroughs could support development of alternative materials and chemistries that are less reliant on critical minerals.

And yesterday, President Biden signed the bipartisan Infrastructure Investment and Jobs Act into law. This bill included billions of dollars to support the development of domestic clean energy supply chains, particularly for battery manufacturing.

And similarly, the Build Back Better Act, if enacted, would refresh the 48C tax credit for investment in clean energy manufacturing facilities.

Our committee's title of Build Back Better includes billions of dollars for DoE grant and loan programs that will support manufacturing of zero-emission vehicles, charging equipment, and other innovative technologies and their components, as well as financial assistance to decarbonize energy-intensive manufacturing. These investments will help revitalize American manufacturing, making us less dependent on foreign nations with inadequate worker and environmental protections.

But this alone will not be sufficient. We must also enhance the recycling and reuse of critical minerals and these clean energy systems.

In Europe, more than 60 percent of the lithium in the economy is recovered through recycling. Today only five percent of lithium ion batteries are recycled in the United States. For comparison, the U.S. recycles 97 percent of traditional lead acid batteries. Recycling policies and investments, as those proposed in the Clean Future Act, would reduce our reliance on foreign nations resource extraction, growing our own supply of these minerals, while creating American jobs.

As we will hear today from Dr. Switzer, there is a strong business case for this work. We know trillions of dollars will be invested in clean energy in the years ahead, and supporting every stage of clean energy technology development will indeed be necessary to position the United States to be the leader of the global clean energy economy.

By understanding the future needs and challenges of this transition, Congress can develop Federal policies that will enable us to rebuild resilient, domestic clean energy technology supply chains, and support millions of American manufacturing jobs.

I look forward to our witnesses' testimony, and I do hope this might be an area where we can work together to support emerging American industries, while reducing our reliance on foreign materials and products.

[The prepared statement of Mr. Tonko follows:]

PREPARED STATEMENT OF HON. PAUL TONKO

The Biden Administration and Democratic members of this Committee have proposed ambitious climate targets—at least 50% economy-wide greenhouse gas emissions reductions from 2005 levels by 2030, at least half of new vehicles sales are electric by 2030, and a carbon-free electricity system by 2035—as well as the policies that will ensure these targets are met.

Achieving these goals will require serious commitment and immediate action.

It will also require building an immense amount of new infrastructure and manufacturing capacity.

Production of clean energy technologies, including wind turbines, solar panels, batteries, advanced vehicles, charging equipment, and electric appliances, will need to be ramped up significantly.

And we will need low-emissions construction materials, like steel and cement, to support clean energy deployment.

The sustainable economy of the future will need to be built and manufactured.

The question that remains to be seen is whether it will be manufactured by Americans.

In recent years, we have heard bipartisan concerns about our increasing reliance on China and other foreign competitors for clean energy technologies.

This is especially true of certain critical minerals. Today, some foreign sources of lithium, cobalt, and nickel involve environmentally harmful practices and unsafe and unethical labor conditions.

In order for the United States to fully seize the opportunities of the clean energy economy, we need to develop our own resilient supply chains.

This may include domestic sources of critical minerals, as well as processing, manufacturing, and recycling capabilities.

Ambitious climate action requires nothing less than fundamental changes to our economy and our energy system.

Any change on this scale will have its challenges. I acknowledge that.

These challenges, including the need to develop domestic supply chains, are not reasons not to act, but rather reasons to discuss how to best overcome these issues in a way that benefits America's workers and entrepreneurs.

Members of Congress have two options: Use this as an excuse to oppose our domestic energy transition and guarantee that our foreign competitors dominate the global economy of the future, or do something about it.

We can support Federal policies that will enable American workers to benefit from the transition, ensuring that we are researching, developing, and deploying the next generation of clean energy technologies in the United States, and exporting them around the world.

This effort is already underway in Congress.

Last year, I worked with Congressman Curtis on a Science Committee bill to authorize a battery and critical mineral recycling research program at DOE, which was enacted in the Energy Act of 2020.

These R&D efforts can make batteries more recyclable, and future breakthroughs could support development of alternative materials and chemistries that are less reliant on critical minerals.

And yesterday President Biden signed the bipartisan Infrastructure Investment and Jobs Act into law.

This bill included billions of dollars to support the development of domestic clean energy supply chains, particularly for battery manufacturing.

And similarly, the Build Back Better Act, if enacted, would refresh the 48-C tax credit for investment in clean energy manufacturing facilities.

Our Committee's title of Build Back Better includes billions of dollars for DOE grant and loan programs that will support manufacturing of zero-emission vehicles, charging equipment, and other innovative technologies and their components, as well as financial assistance to decarbonize energy-intensive manufacturing.

These investments will help revitalize American manufacturing, making us less dependent on foreign nations with inadequate worker and environmental protections.

But this alone will not be sufficient.

We must also enhance the recycling and reuse of critical minerals and these clean energy systems.

In Europe, more than 60% of the lithium in the economy is recovered through recycling.

Today, only 5% of lithium-ion batteries are recycled in the United States. For comparison, the U.S. recycles 97% of traditional lead-acid batteries.

Recycling policies and investments, as proposed in the CLEAN Future Act, would reduce our reliance on foreign nations' resource extraction, growing our own supply of these minerals, while creating American jobs.

As we will hear today from Dr. Switzer, there is a strong business case for this work.

We know trillions of dollars will be invested in clean energy in the years ahead, and supporting every stage of clean energy technology development will be necessary to position the United States to be the leader of the global clean energy economy.

By understanding the future needs and challenges of this transition, Congress can develop Federal policies that will enable us to build resilient, domestic clean energy technology supply chains and support millions of American manufacturing jobs.

I look forward to our witnesses' testimony, and I hope this might be an area where we can work together to support emerging American industries while reducing our reliance on foreign materials and products.

Mr. TONKO. With that I now recognize the ranking member of the Subcommittee on Environment and Climate Change, Representative David McKinley, for 5 minutes, please.

OPENING STATEMENT OF HON. DAVID B. MCKINLEY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WEST VIRGINIA

Mr. MCKINLEY. Thank you, Mr. Chairman. Here, in the United States, inflation is at a 30-year high, and energy prices are the highest they have been in seven years. At the same time, Europe and countries like China are experiencing blackouts and energy rationing. They simply don't have enough capacity to meet the needs, the demands. According to the IEA, the International Energy Agen-

cy, global energy demand is expected still to increase five percent this year, four percent next year and there on after.

Unfortunately, in its rush to meet our dependence—to lessen our dependence on reliable fossil fuels and nuclear in the near term, renewables simply can't keep up with the demand.

So let's take a step back. Rather than this rush to 100 percent renewable energy by 2030 or 2035, wouldn't it make more sense for the United States to invest in carbon capture, and use fossil fuels as a bridge over the next several decades, until we can build out our renewables?

According to NETL, the U.S. is on the brink of capturing carbon in a cost-effective manner. And in so doing, fossil fuels will have zero emissions, just like wind, solar, nuclear. And the U.S., in the meantime, can be developing a long-term strategy for developing our critical minerals and acquiring them, working—developing a long-term solution on our supply chain.

So—but put this in perspective. The World Bank Group and the Center for Strategic and International Studies estimate the demand for mineral production, critical minerals, could increase by 500 to 1,000 percent by the year 2050. Where are we going to get these materials?

Even the Administration's own environmental justice report has said—they published earlier this year—said no additional mining. But the United States is entirely too dependent on China and other nations for the minerals needed for renewables. For example, according to the NMA, the National Mining Association, the United States still imports 76 percent of its cobalt and 100 percent of its graphite from countries like China and the Congo, places with systemic and significant human rights issues.

But this Administration seems more interested in pursuing an anti-fossil fuel agenda by restricting mining in places like Arizona and Minnesota. Remember, just last year, in this very room, former Energy Secretary Moniz said—told us the United States should be mining more, not less.

So, Mr. Chairman, think about what you are doing here. We are restricting mining in America to acquire these critical minerals that we need for renewables, but you don't like getting them from China or Congo, yet demand is clearly outpacing capacity. I have to say you can't have your cake and eat it, too.

I look forward to today's discussion, and I hope that we can come up with a sensible, common-sense approach in this—and adult conversation, as we go through this. We need to find some solutions with this, and I don't think this rush is going to be productive.

[The prepared statement of Mr. McKinley follows:]

PREPARED STATEMENT OF HON. DAVID B. MCKINLEY

Thank you, Mr. Chairman. Here in the U.S. inflation is at a 30-year high; and energy prices are the highest in seven years. Meanwhile, Europe and countries like China are experiencing blackouts and energy rationing. They simply don't have enough capacity to meet the demand. And according to the international energy agency global energy demand is expected to increase: 5% this year; and 4% in 2022.

Unfortunately, in a rush to less our dependence on reliable fossil fuels and nuclear. In the meantime renewables simply can't keep up with that demand. So, let's take a step back. Rather than rush to 100% renewable energy, wouldn't it make

more sense for the U.S. to invest in carbon capture and use fossil fuels as a bridge for the next several decades until we can build out renewables?

According to NETL, the US is on the brink of capturing carbon in a cost-effective manner. In doing so, fossil fuels can have zero emissions—just like wind, solar, and hydro - and the U.S. can develop a longterm strategy for acquiring critical minerals.

So, let's put this in perspective - the World Bank Group and Center for Strategic and International Studies estimate the demand for minerals production could increase by 500% to 1000% by 2050. Where are we going to get these materials?

Even the administration's own environmental justice report says"no additional mining."

But the US is entirely too dependent on China and other nations for the minerals needed for renewables. For example, according to the National Mining Association, the US Imports 76% of its cobalt, and 100% of its graphite, From countries like China and the Congo, places with significant human rights issues.

But this administration seems more interested in pursuing an anti-fossil fuel agenda by restricting mining in places like Arizona or Minnesota. Remember, just last year former Energy Secretary Moniz told this committee the US should be mining more, not less.

Mr. Chairman, think about what you're doing. Restricting mining in America to acquire the minerals needed for renewables, but you don't like getting them from China or the Congo. Yet, demand for energy is clearly outpacing capacity.

I have to say—you can't have your cake and eat it too. I look forward to today's discussion. Thank you, and I yield back.

Mr. MCKINLEY. So I yield back the balance of my time.

Mr. TONKO. The gentleman yields back. The Chair now recognizes Representative Rush, chair of the Subcommittee on Energy, for 5 minutes, Mr. Chair, for your opening statement.

[Pause.]

VOICE. Ask him to unmute.

Mr. TONKO. Chairman Rush, can you please unmute?

[Pause.]

OPENING STATEMENT OF HON. BOBBY RUSH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. RUSH. Sorry, Mr. Chairman. Thank you so very much. Good morning to you, and to all the witnesses, and to the other member of the subcommittees, of the joint subcommittees. I would like first to thank you, Mr. Chairman, for working really closely with me and with my entire staff at the Energy Subcommittee to make today's joint hearing possible.

As we have heard time and time again in my subcommittee, the clean energy transition represents both a challenge and an opportunity. It will be a difficult test, but one that we can achieve to get to net-zero emissions by 2050.

That said, the clean energy transition also represents an enormous opportunity, and it will enable us to move energy production from foreign countries like Saudi Arabia to right back here at home, and to ensure that our clean energy workforce better mirrors the tremendous diversity of America, and also to make energy more affordable for all Americans.

Frankly, Mr. Chairman, we are way behind in our efforts. According to DoE, the United States only produced three percent of the world's solar panels last year, and relied upon imports for roughly 40 percent of the average onshore wind project. Rather than despairing, though, Mr. Chairman, these facts should inspire us to action. Rather than surrendering to a tepid reaction, we must vigorously commit to a robust, take-no-prisoners type of absolute action strategy.

The reality is that we have to compare our clean energy supply chain to the traditional fossil supply chain that we are suffering under today. Despite years of hearing about energy independence from the past Administration, according to the EIA in August, we still relying on crude imports for nearly 40 percent of the oil that was produced and processed in American refineries.

At a time when volatility in energy prices is causing so many consumers pain, we need to speed up the pace at which we make investments in the clean energy supply chain. And any vote to keep our dependence on fossil fuels is a vote to keep America's energy prices volatile, and to expose Americans to unnecessary economic uncertainty.

Finally, Mr. Chairman, as many of my colleagues know, I am passionate about ensuring that the next energy generation economy does not replicate the mistakes of the old one. E2 released a report a few months ago, clearly showing that fossil energy has disproportionately excluded Black and Brown workers, along with women of all colors. The clean energy industry has yet to do significantly better. Mr. Chairman, this is totally disgraceful and unacceptable.

With that, Mr. Chairman, I look forward to today's discussion about the clean energy supply chain.

[The prepared statement of Mr. Rush follows:]

PREPARED STATEMENT OF HON. BOBBY RUSH

Good morning. I would first like to thank my friend, Chairman Paul Tonko of the Environment and Climate Change Subcommittee, for working so closely with me and my staff at the Energy Subcommittee to make today's joint hearing possible.

As we have heard time and time again in my subcommittee, the clean energy transition represents both a challenge and an opportunity. It will undeniably be a difficult task—but one we can achieve—to get to net-zero emissions by 2050. But the clean energy transition also represents an enormous opportunity: it will enable us to move energy production from foreign countries like Saudi Arabia to right here at home, to ensure that our clean energy workforce better mirrors the tremendous diversity of America, and to make energy more affordable for all Americans.

Frankly, at present, we are behind in our efforts. According to the Department of Energy, the United States only produced 3 percent of the world's solar panels last year and relied upon imports for roughly 40 percent of the average onshore wind project. Rather than despair, these facts should inspire us to action. Rather than swear off the clean energy supply chain altogether, we must commit to building it out.

The reality is that we have to compare our clean energy supply chain to the traditional fossil supply chain we have today. Despite years of hearing about energy independence from the Trump Administration, according to the Energy Information Administration, in August, we still relied on crude imports for nearly 40 percent of the oil that was processed in American refineries.

At a time when volatility in energy prices is causing so many consumers pain, we need to speed up the pace at which we make investments in the clean energy supply chain—any vote to keep our dependence on fossil fuels is a vote to keep American's energy prices volatile and to expose Americans to unnecessary uncertainty.

Finally, as many of my colleagues know, I am passionate about ensuring that the next generation energy economy does not replicate the mistakes of the old one. A report from E2 released a few months ago clearly shows that fossil industries have disproportionately excluded Black and Brown workers, along with women of all colors. The clean energy industry has yet to do significantly better. It is simply disgraceful. America's clean energy workforce must look like America, and any opportunity for us to invest in the clean energy supply chain must be partnered with efforts to improve the diversity of the sector. I know that with determination and commitment, we can achieve all of these goals.

With that said, I am looking forward to today's discussion about the clean energy supply chain, and with that, I yield back.

Mr. RUSH. And with that I yield back the balance of my time.

Mr. TONKO. Thank you, sir.

The gentleman yields back. Now the Chair recognizes Representative Upton, the ranking member of the Subcommittee on Energy, for 5 minutes, Mr. Chair, for your opening statement, please.

OPENING STATEMENT OF HON. FRED UPTON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MICHIGAN

Mr. UPTON. Well, thank you, Mr. Chairman. And thanks to our witnesses for appearing before us today.

I have to say America's economy is in trouble. Under President Biden, inflation is surging to record levels, driving up household bills and wiping out savings. Yes, we are in an energy crisis. The average price for a gallon of gas in my Michigan district is over $3.40, the price at the pump has nearly doubled from last year.

We are also in a supply chain crisis, we know that. Shipping backlogs and trucker shortages reveal how critically dependent we are on imports from China and other parts of Asia. Congestion in U.S. ports is also hurting American small businesses and farmers, who depend on a smooth supply chain to send their goods to market. American families and businesses are stuck in the middle on shipping delays and supply chain disruptions.

The worldwide semiconductor chip shortage, and the cascading impact across hundreds of industries—thousands of industries—proves what is at stake when we become overly dependent upon China and overseas manufacturers. As a result of the chip shortage, the Americans—consumers are paying record amounts for new cars, and electronics, and appliances, while dealerships and stores struggle to maintain their inventory.

I am concerned that we are also dependent on China for nearly 90 percent of the critical minerals and materials that are required for some clean energy technologies like wind turbines, solar power panels, batteries.

When it comes to energy, we want to make sure that the supply chain is here, in the U.S., so that our electric bills do not spike simply because of supply chain issues.

In March I introduced the Securing America's Critical Minerals Supply Act to require DoE to address our energy supply chain vulnerabilities, and encourage domestic production and processing.

And over the last decade-and-a-half, the U.S. has emerged as the world's leading producer of oil and gas, and a global energy superpower. After decades of relying on the Middle East for energy imports, the U.S. became a net exporter, a—in 2019, and that is because of the work here, in this committee. America's shale revolution enabled the U.S. to create hundreds of thousands of jobs to undertake a clean energy transition, while at the same time household energy prices dropped to the lowest levels in recent history. America benefitted, and we got used to $2 gasoline and cheap electricity. And those folks now are thinking, why should we have to pay more?

Mr. Chairman, I plan to use today's hearing to explore what is at stake, and what steps Congress ought to take to strengthen our supply chain and address the energy crisis.

Last week the Energy and Commerce Republicans wrote to request hearings on the energy crisis, and preparations for the upcoming winter. It is here. We have serious concerns about rapidly rising energy prices and the negative impact that the price increases are having on the U.S. economy, inflation, and household bills.

We are deeply concerned that the Administration's anti-fossil fuel agenda is significantly contributing to the energy crisis. Revoking pipeline permits; threatening punitive regulations and taxes, such as the proposed natural gas tax in the Build Back Better plan discourages U.S. production. Even more alarming, the Administration is asking OPEC and Russia to drill more, while threatening U.S. workers with a ban on exports, or artificially flooding the domestic market with oil from SPR, the Strategic Petroleum Reserve.

This committee needs to conduct oversight over DoE's handling of the energy crisis to understand better its actions, and what steps Congress may need to take ahead of the upcoming winter.

We also should investigate how regulations may be causing or contributing to energy price increases, and whether the Administration's potential shutdown of Michigan's Line 5 pipeline—this is a pipeline that goes from Canada through Michigan to a refinery in Southeast Michigan—will increase prices even further.

Mr. Chairman, I look forward to today's hearing and working with you to schedule additional hearings in the future to examine the energy crisis.

[The prepared statement of Mr. Upton follows:]

PREPARED STATEMENT OF HON. FRED UPTON

Thank you, Mr. Chairman. And thank you, to our witnesses, for appearing before us today. America's economy is in trouble. Under President Biden, inflation is surging to record levels, driving up household bills and wiping out savings. We are in an energy crisis. The average price for a gallon of gasoline in Michigan is $3.40! The price at the pump has almost doubled from last year.

We are also in a supply chain crisis. Shipping backlogs and trucker shortages reveal how critically dependent we are on imports from China and other parts of Asia. The congestion in U.S. ports is also hurting American small businesses and farmers who depend on smooth supply chains to send their goods to market. American families and businesses are stuck in the middle - while the bills pile up, they are forced to wait on shipping delays and supply chain disruptions.

The world-wide semiconductor chip shortage and the cascading impact across hundreds of industries proves what's at stake when we become overly dependent on China and overseas manufacturers. As a result of the chip shortage, American consumers are paying record amounts for new cars and electronics while dealerships and stores struggle to maintain inventory.

I am concerned that we are also dependent on China for nearly 90% of critical minerals and materials that are required for some clean energy technologies, like wind turbines, solar panels, and batteries. When it comes to energy, we want to make sure the supply chain is here in the United States, so our electricity bills do not spike because of supply chain issues. In March of this year, I introduced the "Securing America's Critical Minerals Supply Act" to require DOE to address our energy supply chain vulnerabilities and encourage domestic production and processing.

Over the last decade-and-a-half, the U.S. has emerged as the world's leading producer of oil and gas and a global energy superpower. After decades of relying on the Middle East for energy imports, the U.S. became a net exporter in 2019. America's Shale Revolution enabled the U.S. to create hundreds of thousands of jobs and

undertake a clean energy transition - while at the same time, householdenergy prices dropped to the lowest levels in recent history. Americans got used to $2 gasoline and cheap electricity - and they are thinking, why should we have to pay more?

Mr. Chairman, I plan to use today's hearing to explore what's at stake and what steps Congress could take to strengthen our supply chains and address the energy crisis.

Last week, Energy and Commerce Republicans wrote to request hearings on the energy crisis and preparations for the upcoming winter. We have serious concerns about rapidly rising energy prices and the negative impacts these price increases are having on the U.S. economy, inflation, and household bills.

We are also deeply concerned that the Administration's anti-fossil fuel agenda is significantly contributing to this energy crisis. Revoking pipeline permits and threatening punitive regulations and taxes—such as the proposed natural gas tax in the Democrats' "Build Back Better" plan—discourages U.S. production. Even more alarming, the Administration is asking OPEC and Russia to drill more, while threatening U.S. workers with a ban on exports, or artificially flooding the domestic market with oil from the Strategic Petroleum Reserve.

This Committee must conduct oversight over DOE's handling of the energy crisis to understand better its actions and what steps Congress may need to take ahead of the upcoming winter. We also should investigate how regulations may be causing or contributing to energy price increases, and whether the Administration's potential shutdown of Michigan's Line 5 pipeline will increase energy prices evenfurther.

Mr. Chairman, I look forward to today's hearing and working with you to schedule additional hearings in the future to examine the energy crisis. Thank you, I yield back.

Mr. UPTON. Thank you, and I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes Chair Pallone, who is the chair of the full committee.

And you recognized, Mr. Chairman, for 5 minutes for your opening statement, please.

OPENING STATEMENT OF HON. FRANK PALLONE, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW JERSEY

Mr. PALLONE. Thank you, Chairman Tonko and Chairman Rush, also, for convening this important joint subcommittee hearing this morning on supply chain solutions for a clean energy economy.

This committee and the Biden Administration are committed to the clean energy transition, and to ambitious decarbonization goals, including a goal of generating 100 percent clean electricity by 2035.

Now, the clean energy transition is underway across the world. Last year annual renewable capacity additions increased by 45 percent worldwide, and that was despite the pressures and challenges of the global COVID-19 pandemic. Domestically, the Energy Information Administration projects the share of renewables in the electricity generation mix to double by 2050. And this is a huge industry that is only getting bigger.

Unfortunately, we are not fully prepared right now to meet this growing demand, and I am concerned that we risk falling behind other countries as they invest in the industries of the future. As an example, today China dominates the production and the assembly of solar photovoltaic modules. China controls over 70 percent of the solar PV module assembly, while over the last year the United States produced only three percent of the modules sold globally. China also has over 75 percent of global cell fabrication capacity, a crucial stage in the battery manufacturing process. In the meantime, the United States has less than ten percent of the market

share for capacity across major battery components and cell fabrication.

With skyrocketing projections for electric vehicle adoption, and the growing necessity of energy storage solutions, this is an industry guaranteed to boom. And as we look ahead, the question is whether we want the United States to lead or follow in the clean energy transition. And I strongly believe that we must lead that transition, so we no longer have to rely on other countries' clean energy supply chains.

It is becoming increasingly clear that key components needed for clean energy technologies are sourced from countries with unacceptable labor and environmental practices. Now, fortunately, the Biden Administration has taken decisive action to halt the import of some goods sourced from countries that violate fundamental human rights. But we can and we must do more.

It is also important to remember that the fossil fuel industry faces some of these same problems. Extraction processes and labor concerns have plagued the traditional energy supply chain for decades. We must build a clean energy economy that tackles the climate crisis by eliminating the historic polluting and poor labor practices of the international fossil fuel industry.

Now, this is one of the many reasons it is critical that Congress pass the Build Back Better Act, which invests heavily in our clean energy future. It includes investments in the deployment of innovative technologies and American manufacturing of zero-emission transportation technologies. This important funding will increase demand for clean energy domestically, while also supporting the development of clean energy supply chains right here, in the United States.

And as we develop these supply chains, it is vital we focus not only on the manufacture of products and technologies, but also on what happens to those goods at the end of their useful lifetime. In the coming decades, as batteries and wind turbines and solar panels reach the end of their lives, we must manage their disposal and recycling in a way that is safe and economically beneficial. Creating circular supply chains that enable collection and re-use of these technologies at the end of their useful lifetimes will not only reduce waste, but also reduce cost and the amount of material needed for the clean energy transition.

So for our nation's future, it is crucial that we support this industry. A strong domestic clean energy industry will ensure we are able to meet our own clean energy goals, and provide millions of jobs for Americans. It will also ensure that, as the world transitions to clean energy, the United States is not left behind. We must work to build these industries here, and we must be competitive, and we must not miss this enormous opportunity for our nation's economy and the global climate.

I did want to mention also, before I yield back, Mr. Chairman, I wanted to thank, as you mentioned, Jacquelyn Cohen for her tremendous contributions to this committee over the last 12 years. As Chairman Tonko mentioned, she played an instrumental role in the passage of the landmark Lautenberg Chemical Safety Act, which modernized the Toxic Substances Control Act for the first time in 40 years. And over the last 12 years Jacqueline's fingerprints are

certainly found on any bill that became law out of our Environment and Climate Change Subcommittee. She had a particular passion for ensuring that all Americans have access to safe drinking water, and for protecting and strengthening the Safe Drinking Water Act. And she is really going to be missed, and I wish her the best in her future endeavors.

[The prepared statement of Mr. Pallone follows:]

PREPARED STATEMENT OF HON. FRANK PALLONE, JR.

I thank Chairmen Tonko and Rush for convening this important joint subcommittee hearing this morning on supply chain solutions for a clean energy economy.

This Committee and the Biden Administration are committed to the clean energy transition and to ambitious decarbonization goals, including a goal of generating 100 percent clean electricity by 2035.

The clean energy transition is underway across the world. Last year, annual renewable capacity additions increased by 45 percent worldwide, and that was despite the pressures and challenges of the global COVID-19 pandemic. Domestically, the Energy Information

Administration projects the share of renewables in the electricity generation mix to double by 2050.

This is a huge industry that's only getting bigger. Unfortunately, we are not fully prepared right now to meet this growing demand, and I am concerned that we risk falling behind other countries as they invest in the industries of the future.

As an example, today China dominates the production and the assembly of solar photovoltaic modules. China controls over 70 percent of solar PV module assembly while, over the last year, the United States produced only three percent of the modules sold globally. China also has over 75 percent of global cell fabrication capacity, a crucial stage in the battery manufacturing process. In the meantime, the United States has less than ten percent of the market share for capacity across major battery components and cell fabrication.

With skyrocketing projections for electric vehicle adoption and the growing necessity of energy storage solutions, this is an industry guaranteed to boom. As we look ahead, the question is whether we want the United States to lead or follow in the clean energy transition.

I strongly believe that we must lead that transition, so we no longer have to rely on other countries' clean energy supply chains. It is becoming increasingly clear that key components needed for clean energy technologies are sourced from countries with unacceptable labor and environmental practices.

Fortunately, the Biden Administration has taken decisive action to halt the import of some goods sourced from countries that violate fundamental human rights. But we can and must do more.

It is also important to remember that the fossil fuel industry faces some of these same problems. Extraction processes and labor concerns have plagued the traditional energy supply chain for decades. We must build a clean energy economy that tackles the climate crisis by eliminating the historic polluting and poor labor practices of the international fossil fuel industry.

This is one of the many reasons it is critical that Congress pass the Build Back Better Act which invests heavily in our clean energy future. It includes investments in the development of innovative technologies and American manufacturing of zero emission transportation technologies. This important funding will increase demand for clean energy domestically, while also supporting the development of clean energy supply chains right here in the United States.

As we develop these supply chains, it's vital we focus not only on the manufacturing of products and technologies, but also on what happens to these goods at the end of their useful lifetime. In the coming decades, as batteries, wind turbines, and solar panels reach the end of their lives, we must manage their disposal and recycling in a way that is safe and economically beneficial. Creating circular supply chains that enable collection and reuse of these technologies at the end of their useful lifetimes will not only reduce waste, but also reduce costs and the amount of material needed for the clean energy transition.

For our nation's future it is crucial that we support this industry. A strong domestic clean energy industry will ensure we are able to meet our own clean energy goals and provide millions of jobs for Americans. It will also ensure that, as the world transitions to clean energy, the United States is not left behind. We must work to

build these industries here. We must be competitive, and we must not miss this enormous opportunity for our nation's economy and the global climate.

I too would like to thank Jacqueline Cohen for her tremendous contributions to this Committee over the last 12 years. As Chairman Tonko mentioned, she played an instrumental role in the passage of the landmark Lautenberg Chemical Safety Act—which modernized the Toxic Substances Control Act for the first time in 40 years.

Over the last 12 years, her fingerprints are certainly found on any bill that became law out of our Environment and Climate Change Subcommittee. She has a particular passion for ensuring that all Americans have access to safe drinking water and for protecting and strengthening the Safe Drinking Water Act. She is going to be missed and I wish her the best in her future endeavors.

Mr. PALLONE. And with that, Mr. Chairman, I yield back.

Mr. TONKO. The Chairman yields back. The Chair now recognizes Representative Rodgers, who serves as ranking member of the full committee.

Mrs. Rodgers, you are recognized for 5 minutes, please, for your opening statement.

OPENING STATEMENT OF HON. CATHY MCMORRIS RODGERS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WASHINGTON

Mrs. RODGERS. Thank you, Mr. Chairman.

Record inflation, spiking prices, empty store shelves and car lots, growing risk of blackouts: families are learning what failing energy and economic policies feel like. Global supply chain disruptions and demand shocks from the COVID pandemic have taken a toll.

Now the Administration is making this crisis worse with its reckless inflationary spending and an anti-American energy agenda: shutting down pipelines, banning oil and gas lease sales, imposing new energy taxes, and systematically shutting down American energy.

Unbelievably, President Biden is even considering shutting down a major—another major energy infrastructure project, Michigan's Line 5 pipeline, right before winter. Closing Line 5 would cost thousands of jobs, and increase the price of heating fuels like propane, which are already in short supply across the nation. This is threatening people's livelihoods.

We have requested hearings with the Secretary of Energy so that we can examine this immediate crisis, especially the surging costs right before winter.

This oversight should also question what the rush to green regulatory agenda means for supplies and affordability of energy. Policies to make sure people have access to affordable, reliable energy must remain central to this committee's work, and that is especially true for today's hearing. We must recognize the amazing value of our existing energy infrastructure for economic growth, and ensuring that people have a chance for a better life and strengthening national security. Energy security is national and financial security.

We have witnessed the wide-ranging benefits of the American energy renaissance brought about by the shale revolution, lifting people out of poverty, raising the standard of living to the highest level ever. This has revitalized communities, created hundreds of billions of dollars of jobs in economic activity, and thousands of new jobs. It has provided strong security benefits in America, and lowered

carbon emissions more than any other nation in the world, more than the next 12 combined. We win the future by building on the foundations of this energy infrastructure, not by destroying it.

This rush to green radical agenda attacks American energy, mandates expansion of weather-dependent wind and solar and massive electrification. This vision is to replace our energy infrastructure at a pace and scale that defies historical experience. To say that it is possible is divorced from reality. It will lead to higher cost, less reliable energy. It will create energy poverty, and reduce our quality of life.

This is why Republicans have repeatedly raised concerns about the economic and security dangers of the rush to green. The World Bank estimates renewable mandates will increase global demand for certain critical minerals 500 percent over current rates—that is a lot of mining and processing—and massive growth in our domestic mining and industrial infrastructure. New mandates will require more reliance on foreign supplies of minerals and materials. That means a dangerous dependence upon China and its use of slave labor and abusive practices in the renewable and EV supply chains.

All of us should be asking how do Americans benefit, if President Biden trades our strategic advantage in energy infrastructure for more dependence on China supply chains? We should never let that happen.

So how do we develop our own secure supplies for these minerals? Accelerate the mining, processing, and permitting. The International Energy Agency concluded in a recent report that it takes more than 16 years to bring a mine from discovery to initial production. How does that timeline fit with the 2020, 2035, 2050, whatever mandate, from the Biden Administration? I hope we can get some answers today.

Radical green mandates seek to replace extraction of energy minerals, oil, gas, coal, and uranium with extraction of non-energy minerals of lithium, cobalt, rare Earths in magnets and batteries. I am all for increasing our domestic supply of critical minerals, but the reality is keep-it-in-the-ground movements apply to fossil fuels and critical minerals. This drive to renewables has a host of land use, disposal, and environmental costs beyond greenhouse gas emissions.

We need a smart strategic approach, rooted in reality, to secure a cleaner energy future. We should be using our abundant resources and American ingenuity and creativity. That is the American way. That means shale, gas, hydropower, and, of course, nuclear energy. It is oddly absent from today's hearing.

We must lead, lead the American way, protect people's livelihoods, and ensure that we continue to raise the standard of living.

[The prepared statement of Mrs. Rodgers follows:]

PREPARED STATEMENT OF HON. CATHY MCMORRIS RODGERS

Record inflation, spiking prices, empty store shelves and car lots, growing risks of blackouts, families are learning what failing energy and economic policies feel like. Global supply chain disruptions and demand shocks from the Covid pandemic have been bad enough.

The Administration is making this crisis worse with its reckless inflationary spending and an anti-American energy agenda. Killing pipelines, limiting oil and

gas lease sales, imposing new energy taxes, and talking relentlessly about ending American use of fossil energy. Unbelievably, President Biden is even considering closing another major energy infrastructure project, Michigan's Line 5 pipeline, right before winter. Closing Line 5 could kill thousands of jobs and increase the price of heating fuels, like propane, which are already in short supply across the nation. This is threatening people's livelihoods.

Committee Republicans have requested hearings with the Secretary of Energy, so we can examine the immediate crisis, especially surging costs expected this winter. This oversight should also question what the rush-to-green regulatory agenda means for the supply and affordability of energy. Policies to make sure people have access to affordable, reliable energy must remain central to this Committee's work.

And that is especially true for today's hearing.

We must recognize the amazing value of our existing energy system for economic growth and ensure people have the chance for a better life, and for strengthening geopolitical security. Energy security IS national and financial security.

We have witnessed the wide-ranging benefits of the American energy renaissance brought about by the shale revolution. This has revitalized communities, created hundreds of billions of dollars in economic activity, and thousands of new jobs. It has provided strong security benefits in America and lowered carbon emissions more than any other nation on earth. We win the future by building on the foundations of this energy system-not by destroying it.

This "rush to green," radical agenda attacks fossil fuel use and mandates expansion of weather-dependent wind and solar, and massive electrification. The vision is to replace our fossil energy systems at a pace and scale that defies historical experience. To say it's possible is to be divorced from reality.This will lead to higher costs and less reliable energy. This is why Republicans have repeatedly raised concerns about the economic and security dangers of the rush to green. The World Bank estimates renewable policies will increase global demand for certain critical minerals 500% over current rates.

That's a lot of mining and processing to keep prices down. Absent massive growth in our domestic mining and industrial infrastructure, new mandates will require more reliance on foreign supplies of minerals and materials. That means a dangerous dependence upon China, and its use of slave labor and abusive practices in the renewable and EV supply chains.

All of us should be asking: how do Americans benefit if President Biden trades our strategic advantage in fossil energy for more dependence on Chinese supply chains? We should not let that happen.

So how do we develop our own secure supplies of these minerals, accelerate the mining, processing, and permitting? The International Energy Agency concluded in a recent report that it takes more than 16 years to bring a mine from discovery to initial production.

How does that timeline fit in with the, by 2030, by 2035, by 2050 taglines from the Biden Administration and the Left? I'm hopeful we can get some answers today. Radical green policies seek to replace extraction of energy minerals-oil, gas, coal, and uranium-with extraction of non-energy minerals—the lithium, cobalt, rare earths in magnets and batteries.

I am all for increasing our domestic supply of critical minerals, but the reality is, "keep it in the ground" movements apply to fossil fuels and critical minerals. This drive to renewables also has a host of land use, disposal, and environmental costs beyond greenhouse gas emissions. How does that fit into our environmental priorities?

We need a smart, approach-rooted in reality—to secure a cleaner energy future. We should be using our abundant resources and American know-how. That means shale gas, hydropower, and of course nuclear energy, something oddly absent from this hearing on clean energy.

We can do it right if we reject radical visions that deprive us of the benefits of American resources, that stifle innovation with mandates, and that undermine affordable, reliable energy. This is about protecting people's livelihoods and ensuring they can raise their standard of living. I hope we can discuss this morning what is needed to get this right today and in the future.

Mrs. RODGERS. I yield back

Mr. TONKO. The gentlelady yields back.

The Chair reminds Members that, pursuant to committee rules, all members' written opening statements shall be made part of the record.

I now move to introduce the witnesses for today's hearing.

We will be beginning with Mr. Ethan Zindler, head of Americas, Bloomberg NEF. He will be followed by Ms. Roxanne Brown, international vice president at large with the United Steelworkers, to be followed by Dr. Jackson Switzer, senior director of business development of Redwood Materials, and then, finally, Mr. Lucian Pugliaresi, president of Energy Policy Research Foundation, Inc.

And I welcome all of our witnesses today, and thank you for your time and your information that you will share. At this time the Chair will recognize each witness for 5 minutes to provide his or her opening statement.

Before we begin, I would like to explain the lighting system. In front of our witnesses is a series of lights. The light will initially be green. The light will turn yellow when you have one minute remaining. Please begin to wrap up your testimony at that point. And the light will turn red when your time has expired.

So we begin now by recognizing Mr. Zindler for 5 minutes to provide an opening statement, please.

STATEMENT OF ETHAN ZINDLER, HEAD OF AMERICAS, BLOOMBERGNEF; ROXANNE BROWN, INTERNATIONAL VICE PRESIDENT AT LARGE, UNITED STEELWORKERS; JACKSON SWITZER, PH.D., SENIOR DIRECTOR OF BUSINESS DEVELOPMENT, REDWOOD MATERIALS; AND LUCIAN PUGLIARESI, PRESIDENT, ENERGY POLICY RESEARCH FOUNDATION, INC. (EPRINC)

STATEMENT OF ETHAN ZINDLER

Mr. ZINDLER. There we go. Good morning, and thank you for this opportunity, Chairman Tonko, and Chairman Rush, and Ranking Members Upton and McKinley.

I am here today in my role as an analyst at BloombergNEF, a division of financial information provider Bloomberg L.P. Our group provides investors, utilities, oil majors, policymakers, and others with data and insights on the energy world, and other sectors of the global economy undergoing fundamental rapid transformation. My remarks today represent my views alone, not the corporate positions of Bloomberg L.P., and, of course, they do not represent specific investment advice.

Progress in the energy industry and transportation industry used to be measured in decades. Its sheer scale meant that the adoption of fuels or technologies was, by definition, slow and laborious. Today, however, how the world generates, delivers, and consumes energy are all not only being transformed radically, but also very rapidly. Both around the world and here, in the U.S., clean energy technologies are no longer at the margins, but very much at the center of change.

In 2020, wind, solar, geothermal, and biomass accounted for 12 percent of global electricity production. That was up from 9 percent in 2018, and just four percent in 2011. Two-fifths of global power came from zero-carbon sources, including nuclear power. In the U.S., the wind and solar share of power generation has doubled in a decade, and 20 percent of our power in 2020 came from all re-

newable sources, including hydro. The vast majority of new capacity added to the grid in the last two years has been wind and solar.

A similar transformation is underway in road transportation, albeit at an earlier stage. In 2015, consumers purchased about half-a-million electric vehicles, worldwide. This year we are on track to see at least 5 million EVs sold, and EVs' share versus internal combustion engine cars has nearly tripled since 2019, to 7.2 percent in the first half of 2021.

Government policies, most notably in China and the EU, have boosted EV sales, but public acceptance and outright enthusiasm for EVs is growing, as well. The cars run quieter, they generally require less maintenance, and they have fewer moving parts. They offer outstanding acceleration, and anybody who has driven one will tell you they are also a lot of fun to drive.

Clean energy's growth has, of course, created major economic development opportunities. Our firm, BloombergNEF, has tracked over $4 trillion invested in this space since 2004. But far more lucrative opportunities lie ahead. Renewable power projects alone will track no less than $10 trillion through 2050, our firm projects. Grid expansions and upgrades will top about $11 billion. Charging infrastructure will need at least $600 billion in the next 20 years.

With this fundamental transformation underway, the question is which companies and which countries stand to reap the most economic benefits. Despite its extraordinary resources, most notably its human resources, today the U.S. is not positioned to lead in these rapidly-expanding segments of the global economy. The reasons why are detailed in several reports that I shared with the committee, and that we produced with the Center for Strategic and International Studies. But here are a couple of quick takeaways.

When it comes to manufacturing solar PV equipment, the U.S. today is, effectively, a bit player, despite being the second-largest demand market for such equipment. Chinese companies dominate virtually every segment of the manufacturing value chain for silicon PV modules.

In wind turbine production, the story is a bit more complex, in part because these are such specialized pieces of equipment, and partly because they are expensive to ship.

When it comes to electric vehicles, the most critical and costly component is the battery. In terms of volume, the U.S. today is a laggard in the final assembly of such batteries, and in the production of battery components. China and South Korea are primary suppliers, with Europe coming on very quickly.

What specific policies could trigger U.S. clean energy manufacturing growth? For clues, it is worth examining the challenges and successes Germany, India, and, particularly, China have achieved.

In our research with CSIS, we found that, to attract the private investment required to scale manufacturing, equipment-makers must believe that significant local demand exists for their products, both in the short and the long term. I raise this point because, in the context of China, which is not only the largest supplier of clean energy goods on Earth by far, but the largest demand market for such equipment, as well, there has been a lot of attention paid to how China subsidizes manufacturing of clean energy equipment by making low or zero-interest loans available. While that is certainly

true, China has also created significant demand for clean energy goods and services by offering higher tariffs for zero-carbon power, or offering rebates for the purchases of electric vehicles.

I am going to close real quick by just offering one final comment.

Before today, Congress has legislation that can send the very signals that are required to trigger a U.S. clean energy manufacturing scale-up. The infrastructure bill passed the other day marked an important step in this direction, with its support for transmission, EV charging, and other technologies, including carbon capture and nuclear power. But it is the currently pending Build Back Better legislation that stands to make a far bigger impact in this area. By focusing both on the supply and demand side of the clean energy equation, the bill has the potential to unleash an unprecedented wave of investment and manufacturing capacity on U.S. soil.

Thank you again for this opportunity. I look forward to your questions.

[The prepared statement of Mr. Zindler follows:]

Testimony before the
House Committee on Energy & Commerce
Energy and Environment Subcommittees
Ethan Zindler
Head of Americas
BloombergNEF
November 16, 2021

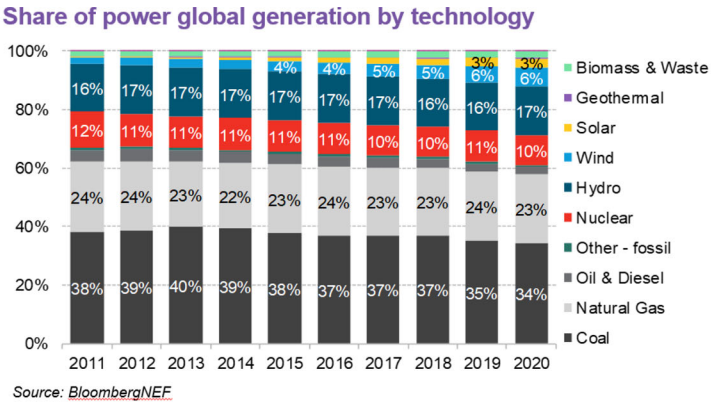
Good morning and thank you for this opportunity, Chairmen Tonko and Rush and Ranking Members Upton and McKinley.

I am here today in my role as analyst at BloombergNEF, a division of financial information provider Bloomberg L.P. Our group provides investors, utilities, oil majors, policy-makers, and others with data and insights on the energy world and other sectors of the global economy undergoing rapid transformation. My remarks today represent my views alone, not the corporate positions of Bloomberg L.P. And of course, they do not represent specific investment advice.

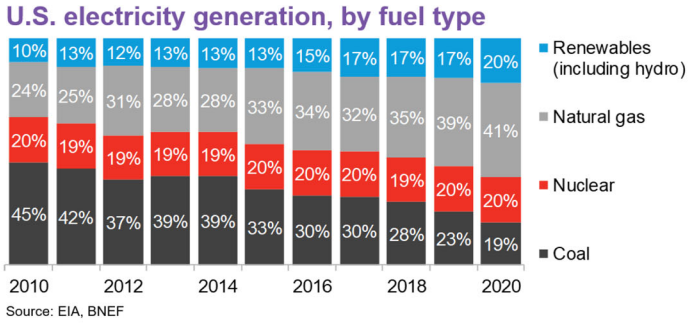
Progress in the energy industry and transportation sector used to be measured in decades. Its sheer scale meant that the adoption of fuels or technologies was, by definition, slow and laborious.

Today, however, how the world generates, delivers, and consumes energy are all not only being transformed radically – but also rapidly. Both around the world and here in the U.S. clean energy technologies are no longer at the margins, but very much at the center of change.

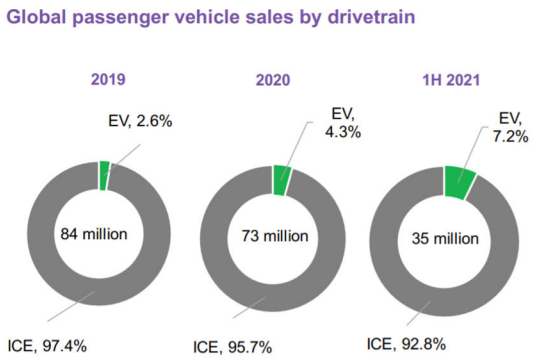
In 2020, wind, solar, geothermal and biomass accounted for 12% of global electricity production. That was up from 9% in 2018 and just 4% in 2011. Two-fifths of global power came from zero-carbon sources, including nuclear power.



In the U.S., wind and solar's share of power generation has doubled in a decade and 20% of our power in 2020 came from all renewable sources. The vast majority of new capacity added to the grid in the last two years has been wind and solar.

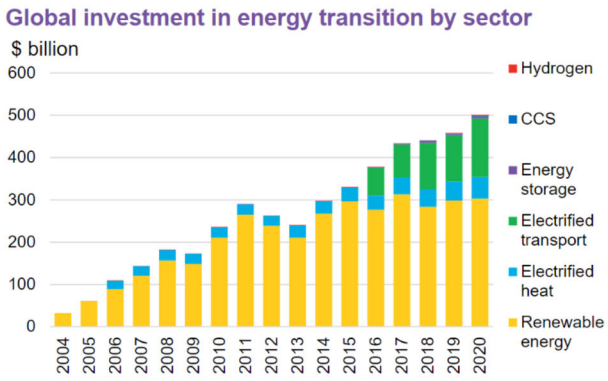


A similar transformation is underway in road transportation, albeit at an earlier stage. In 2015, consumers purchased 0.5 million electric vehicles worldwide. This year, we're on track to see at least 5 million sold and EVs' share vs. internal combustion engine (ICE) cars has nearly tripled since 2019 to 7.2% in the first half of 2021.



Government policies, most notably in China and the EU, have boosted EV sales. But public acceptance and outright enthusiasm for EVs is growing. The cars run quieter, generally require less maintenance and have fewer moving parts. They offer outstanding acceleration. They're also really fun to drive.

Clean energy's growth has, of course, created major economic development opportunities. Our firm has tracked over $4 trillion in energy transition investment since 2004.



Source: BloombergNEF. Note: start-years differ by sector.

Far more lucrative opportunities lie ahead. Renewable power projects alone will attract no less than $10 trillion through 2050, our firm projects. Grid expansions and upgrades will top $11 trillion. The charging infrastructure for EVs is projected to total approximately $600 billion over the next 20 years.

With this fundamental transformation underway, the question is: which companies and which countries stand to reap the economic benefits?

Despite its extraordinary resources – most notably, its human resources – today, the U.S. is not positioned to lead in these rapidly expanding segments of the global economy. The reasons why are detailed in several reports my firm produced with the Center for Strategic and International Studies earlier this year and are referenced in the memo circulated by Chairman Pallone.

Here are a few quick takeaways:

When it comes to manufacturing of solar photovoltaic (PV) equipment, the U.S. today is effectively a bit player, despite being the second largest demand market for such equipment. Chinese companies dominate virtually every segment of the manufacturing value chain for silicon PV modules.

In wind turbine production, the story is a bit more complex. In part because these are such specialized pieces of equipment and partly because they are expensive to ship, the U.S. does meet most of its demand for completed wind turbines locally. However, turbines installed in the U.S. typically contain substantial volumes of components manufactured abroad.

When it comes to electric vehicles, the most critical and costly component is the battery. In terms of volume, the U.S. today a laggard in the final assembly of such

batteries and in the production of battery components. China and South Korea are primary suppliers with Europe coming on strong.

What specific policies could trigger U.S. clean energy manufacturing growth? For clues, it's worth examining the challenges and successes Germany, India and particularly China have achieved.

In our research with CSIS, we found that to attract the private investment required to scale manufacturing, equipment makers must believe significant local demand exists for their products, both in the short and long term.

I raise this point in the context of China, which is not only the largest supplier of clean energy goods on earth – by far – but the largest demand market for such equipment as well.

There has been plenty of attention paid to how China subsidizes the manufacturing of clean energy equipment by making low- or zero-interest capital available to producers. While that is true, China has also created significant demand for clean energy goods by offering higher tariffs for zero-carbon power, or offering rebates for the purchase of EVs or plug-in hybrid EVs.

The U.S. still has the opportunity to become a major player in the production of certain clean energy goods. But achieving scale-up will require a holistic approach to policymaking and the recognition that many of the largest, most sophisticated manufacturing facilities will only come on line if there is sufficient confidence about local demand.

I will close by noting that Congress has before it today legislation that can send the very signals needed to trigger a U.S. clean manufacturing scale-up. The

infrastructure bill passed the other day marked an important step in this direction with its support for transmission, EV charging, and other technologies.

But it is the currently pending Build Back Better legislation that stands to make a far bigger impact in this area. By focusing both on the supply and demand side of the clean energy equation, the bill has the potential to unleash an unprecedented wave of investment in manufacturing capacity on U.S. soil.

Thank you again for this opportunity. I look forward to your questions.

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Mr. TONKO. Well, we thank you, Mr. Zindler and, again, welcome.

And now we welcome Ms. Brown.

You are recognized for 5 minutes, please.

STATEMENT OF ROXANNE BROWN

Ms. BROWN. Chairman Pallone, Ranking Member Rodgers, Chairman Tonko, Chairman Rush, Ranking Member McKinley, Ranking Member Upton, and members of the subcommittees, my name is Roxanne Brown, and I am proud to serve as international vice president at large for the United Steelworkers Union. Thank you for the opportunity to testify today at this important hearing to discuss supply chains for the clean energy economy.

As the largest industrial union in North America, USW members make the products, components, subcomponents, and raw materials that underpin our manufacturing economy now, and which will be necessary to build the clean energy economy. Manufacturing is where much of the economic benefit will lie for communities and workers, as new technologies are deployed, and as we rebuild our nation's infrastructure. It can and must be a driver of the creation and retention of good, family-supporting union jobs throughout the economy.

But I have to be honest. Not everyone is looking forward to the transition of the U.S. and global economy to a clean energy one. American manufacturing workers have a great deal of skepticism about what this will mean for their jobs, for them, and for their communities. That skepticism is well-founded, after so many decades of policy-making have left manufacturing communities hollowed out.

Our union has been having the green jobs conversation with our members for almost 20 years now. And for many of them, that promise has not been realized. We have so many examples of USW members working in clean energy supply chains who have lost jobs, instead of those jobs flourishing. Whether it is our members at Rotek in Aurora, Ohio, who, ten years ago, made a higher share of large diameter bearings for onshore wind, but were impacted by foreign-made bearings coming into the market, or our members at Corning and PPG Industries, who made glass for solar panels at one time, but couldn't compete, once China's industrial policies sought to dominate the global market.

Earlier this year, USW member Joe Wrona testified before the Senate Finance Committee about how his plant announced efforts to expand into the solar supply chain, only to close less than a decade later, in part because of China's dominance in the industry.

This regrettable history does not have to continue into the future. For this transition to be successful, manufacturing workers and their communities must be the leaders of these—of this transition, not the victims of it. We have an opportunity to reverse what has happened in manufacturing sectors across the United States supply chain, and we—and have our members, you know, believe our union, believe Congress, believe the Administration when we all say that manufacturing will be the driver of the clean energy economy.

The policy environment is creating some opportunities, as we will see, once this infrastructure bill that was signed tomorrow is implemented—yesterday, was implemented. But more can be done to ensure both economic and environmental sustainability as we move towards a clean energy economy. Our union is committed to seeing both of these things through. But if we do one, and not the other, then we don't succeed. My written testimony details the policy pieces our union believes are necessary to help achieve both of these goals, but I would like to highlight a few.

First, policymakers must consider the broad suite of clean energy technologies like wind, solar, geothermal, nuclear, and battery storage, and develop strategies for the supply chain for each of them. This should also include supply chains for building materials for energy efficiency, carbon management like utilization and direct air capture, batteries and charging stations for electric vehicles, and emerging fuels like hydrogen.

Second, secure domestic supply chains will only grow if intentional choices are made to develop sound industrial policy, and a strategy for investing in the manufacture of these technologies. This is what other countries are doing, and it is necessary for us to compete globally.

Finally, a foundational bedrock of investing in manufacturing is Buy America policy. It creates demand for manufacturing and materials, and provides certainty to companies, which is necessary when those companies take risks to retool and make materials for new technologies. Taxpayers overwhelmingly support their dollars being spent to create jobs here in the United States.

Our union looks forward to working with you to make our vision a reality for manufacturing workers. I have spent a lot of time over the last 15 years testifying, and speaking on panels about the hope of the clean energy economy for my members and, really, for domestic industry. And it has been too long to be having this conversation. We have a real opportunity right now to make our goals and our vision about what the domestic manufacturing can do for the clean energy sector a reality, and we look forward to working with you to get that done. Thank you.

[The prepared statement of Ms. Brown follows:]

Testimony

of

Roxanne Brown
International Vice President At Large
The United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW)

for the

Subcommittee on Environment and Climate Change and the Subcommittee on Energy

of the

Committee on Energy and Commerce

hearing on

"Securing America's Future: Supply Chain Solutions for a Clean Energy Economy"

November 16, 2021

Chairman Tonko, Chairman Rush, Ranking Member McKinley, Ranking Member Upton, and members of the subcommittees, my name is Roxanne Brown. I am honored to serve as International Vice President at Large for the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union, commonly known as United Steelworkers or USW. I thank you for the opportunity to testify today at this important hearing. Our union is grateful to you for holding this hearing to discuss supply chains for the clean energy economy. Manufacturing is, of course, where much of the economic benefit will lie for communities as new technologies are deployed and as we rebuild our nation's infrastructure.

Introduction

The United Steelworkers is the largest industrial union in North America with membership primarily concentrated in energy-intensive, trade exposed industries. Our members work throughout the potential supply chain of all of the products, components, subcomponents, and raw materials that underpin our manufacturing economy now, and which will be necessary to build the clean energy economy. USW members stand ready to build the clean energy economy, which if managed correctly, can and will be a driver of the creation and retention of good, family-supporting jobs throughout the economy

The economic transition driven by both policy and corporate decisions is underway and only accelerating will be nothing less than the most massive economic undertaking this nation has ever attempted, and both the potential gains and potential losses are enormous. Simply put, the transition to a clean energy economy is a huge manufacturing effort, and if done correctly and with adequate governmental support, can and will ensure the preeminence of the American manufacturing sector for the rest of the 21st century and beyond. This will only happen, however, if we ensure that the products and materials that will be required are made here in America by American workers.

American manufacturers and manufacturing workers are the best in the world, with the most efficient production methods and best environmental performance. If our energy goals, our climate goals, and our economic goals are to be achieved, it is crucial that this already-existing base of excellence is not only maintained, but expanded as we build out a supply chain of American-made products that will be the backbone of the clean energy economy now and in the future.

Identifying Clean Energy Supply Chains and Domestic Sources

As the economy changes, many of the existing technologies will either be changed or replaced. This is an exciting time for innovation, and it presents a lot of opportunity for economic growth in the United States.

The first step in securing domestic supply chains for the clean energy economy is to identify the technologies for with it is strategic and necessary for the United States to have a reliable domestic supply chain. Energy security of the future will not just be defined based on where our fossil fuels come from, but also by whether we can manufacture the materials necessary to generate clean power from renewable sources and other clean energy technologies, like nuclear energy.

Congress and the Administration must consider the broad suite of clean energy technologies – like wind, solar, geothermal, nuclear, and battery storage – as strategic and develop strategies for the supply chain for each of them. We also urge you to pay special attention to the supply chains for other technologies important to our clean energy future aside from power generation as well, including building materials for energy efficiency; carbon management like utilization and direct air capture; batteries and charging stations for electric vehicles; and emerging fuels like hydrogen. It is also important that lawmakers leave open the possibility that there are technologies to be developed and don't limit policy frameworks to existing technologies.

Develop an Industrial Policy

Secure domestic supply chains will only grow if Congress and the Administration make intentional choices to develop sound industrial policy and a strategy for investing in the manufacture of these technologies. This is what other countries are doing, and it is necessary for us to compete globally.

An example we should learn from is the solar industry. This technology was developed years ago using Department of Energy (DOE) funding, yet our government did not prioritize retaining manufacturing once the technology was commercialized. U.S. manufacturers did make some components over the years. For example, USW members at Corning made glass for solar panels at one time, but they could not compete once China's industrial policy sought to dominate the global market. USW members in other industries could have also made other solar related components and seen job loss to anti-competitive practices by China. Earlier this year, USW member Joe Wrona testified at the Senate Finance Committee about how his plant announced efforts to expand into the solar supply chain only to close less than a decade later in part because of China's dominance in the industry.[1]

Now, the solar supply chain is dominated by China and reliant on forced labor in the Xinjiang Region. Our union and the AFL-CIO agree that this has to change.[2] The United States government must make a commitment to maintain, strengthen and expand the withhold release order (WRO) applied to solar products produced in whole

[1] https://www.finance.senate.gov/imo/media/doc/Wrona,%20Joe%20(USW)%20-%20Testimony%20for%20SFC%20Forced%20Labor%20Hearing.pdf
[2] https://aflcio.org/about/leadership/statements/building-clean-energy-jobs-global-solar-supply-chain

or in part with forced labor. It must also commit to building out the solar supply chain in the United States.

Another example to learn from is the lithium ion battery supply chain. This is the most widespread technology for electric vehicles at this time. The European Union has developed a multi-faceted strategy that includes the European Battery Alliance, research & development investments, policy on sustainable battery supply chains, and rules of origin on localization of the lithium ion battery supply chain. The United States needs a similar multifaceted policy ecosystem aimed at growing manufacturing to build our own supply chain for batteries to compete in the global economy.

We can and should learn from these policies by other countries and not make the same mistakes twice. The United States should ensure that technology developed here with U.S. taxpayer dollars is also manufactured and deployed here.

Long-Term Investments in American Manufacturing

A foundational bedrock of investing in manufacturing is Buy America policy, which creates demand for manufactured materials and provides certainty to companies, which is very necessary when manufacturers are taking risks to retool facilities to make new materials for a new technology. This is important whenever taxpayer money is spent to support the buildout of infrastructure or growth of technologies because taxpayers overwhelmingly want that money to be spent creating jobs here in the U.S.

Buy America works best, driving production and job growth in the U.S. while preventing cost or time overruns in projects, when it is applied consistently and strongly. In short, federal spending or federal assistance for the buildout of clean energy technologies should be accompanied by a Buy America requirement.

To provide one example of where Buy America requirements would have helped, I want to point you to the USW-represented facility in Aurora, OH where our members make giant ring bearings. About a decade ago, eager to capitalize on the opportunities in the wind energy market, the company secured investments in the facility, hired additional workers, and began producing the huge metal rings for wind turbines. But they could not compete with foreign-made products and eventually eliminated those jobs created a few years earlier because they did not have stable wind energy customers.[3]

In addition to those demand-side policies, Congress should also look to implement supply-side policies to help U.S. companies grow these supply chains from mineral extraction to manufacturing and end-of-life recycle of the materials.

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[3] https://www.usw.org/blog/2021/investing-in-american-prosperity

Of course, critical minerals are necessary for these technologies, and the Administration has identified some of the most strategic minerals in these supply chains. Our union is a mining union, and we support the permitting for responsible extraction of these minerals here in the United States, where deposits exist, and the development of trading relationships with reliable allies who also prioritize responsible mining.

The members of USW Local 11-0001 at the Sibanye-Stillwater mine in Montana provide a good model for responsible mining with their Good Neighbor Agreement that is two decades old. This agreement between the company, the union, and the community outlines a joint decision-making process for making changes at the mine and protecting the environment, while still allowing for the extraction of platinum, palladium, copper, silver, and nickel to sell to medical, defense, and clean energy customers.[4]

Congress has already taken important steps on critical minerals with the passage of the Infrastructure Investment and Jobs Act ("IIJA") (H.R. 3684) by creating new initiatives at DOE on critical minerals R&D on mining, recycling, and reclamation and expansions to eligibility under DOE loan programs.

Manufacturing of the many materials and components for clean energy supply chains must be similarly prioritized by working with manufacturers to help them understand market opportunities and retool to make materials for these clean technologies.

Our union has long advocated for funding support for key domestic clean energy manufacturing in the form of an industrial bank or broader manufacturing grant and loan programs to support the retooling of existing facilities and the standing up of new manufacturing facilities. The Build Back Better Act (H.R. 5376) contains many important provisions that speak to these recommendations, such as the revival of the 48C tax credit, the creation of clean technology supply chain manufacturing tax credits, funding to the DOE Advanced Industrial Facilities Deployment Program and Loan Program Office, along with funding to the Department of Commerce for identifying, demonstrating, and deploying advances for manufacturing supply chains and supply chain resiliency.

Congress should also investigate and help stimulate the opportunity for new and existing businesses at the end of life of some of these clean energy technologies. R&D efforts should help ensure these technologies can be disassembled and the materials can be reprocessed by U.S. businesses to be put back into the supply chain. This will be particularly important for batteries, but is also relevant for other technologies, like wind turbines.

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[4] https://www.usw.org/blog/2021/confronting-the-next-crisis

U.S. manufacturers and their workers can and will adapt to make materials for the clean energy economy if they have the opportunity. The federal government must support their efforts by identifying strategic supply chains and components, helping to create demand for U.S.-made products, and supporting R&D and manufacturing retooling.

Competitiveness & Challenges from Abroad

A well-designed suite of supply-side investments and demand-side drivers can and will spur the development of domestic supply chains for clean energy projects and throughout the economy. Still, Congress must be mindful that as this transition progresses both as a part of and alongside the U.S.'s climate goals and reduced greenhouse gas emissions, the potential exists that upfront costs to manufacturers will arise. This is particularly true for energy-intensive, trade-exposed manufacturers like many where USW members work.

Because these industries are uniquely sensitive to energy costs and trade pressures, they are uniquely at risk of facing rapid and massive production shifts offshore if care is not taken to prevent this leakage of both jobs and emissions. If leakage is allowed to occur, much of the gains already realized and on the horizon from the building out of these supply chains will be imperiled or hollowed out.

In many cases, the supply and demand-side drivers I discussed previously will ameliorate these risks, but it is not guaranteed that it will eliminate all such risks. Congress must be willing and ready to take action immediately to prevent leakage if it arises. This action may come in the form of a carbon border adjustment mechanism or some other policy. The key, however, must be swift action. In commodity industries, even small cost increases not borne by foreign competitors can cause massive and fast production shifts offshore. Ensuring this does not happen is absolutely critical to ensuring that the development of supply chains for the clean energy economy achieves its promise of creating and maintaining good, family-supporting jobs throughout the supply chain and throughout the U.S.

United States Innovation and Competition Act (USICA)

The USW has been closely monitoring the House response to S.1260, the United States Innovation and Competition Act of 2021. The legislation has the potential to dramatically upgrade U.S. international competitiveness if constructed in a fashion that ensures good jobs and environmental policies are built into the legislation. Working with the Energy and Commerce Committee, and Representatives Blunt-Rochester, Malinowski, and Kinzinger, we are pleased to support H.R. 5495, the Building Resilient Supply Chains Act. This legislation would establish an office of supply chain resiliency and crisis response to encourage manufacturing growth and other key policy priorities.

The legislation has the potential to provide significant fiscal resources to retool American manufacturing in critical supply chains, but also contains provisions that will ensure federal dollars create good jobs and discourages corporations from using federal dollars to fight worker rights. An employee's voice in their workplace has been a commerce issue since the establishment of the National Labor Relations Act (NLRA) in 1935. Commerce is mentioned 69 times in the original NLRA alone.[5] As the federal government renews our economic leadership, fighting inequality must not be put in doubt, and H.R. 5495 strikes an effective balance of worker/employer power when federal dollars can provide up to 80 percent of a project's costs.

The union is also closely reviewing and has significant reservations regarding H.R. 5492, the Manufacturing Economy and National Security Act. Provisions in the bill which would provide federal resources to move supply chains from "countries of concern" to third party countries could lead to reduced reshoring of manufacturing and corporations using federal dollars to shift goods that have existing anti-dumping and countervailing duty orders (AD/CVD) to third party countries to then dump goods into the U.S. market again. The legislation also makes no effort to ensure shifted production does move to countries which have higher greenhouse gas emissions or equivalent environmental standards than the U.S.

H.R. 5492 also provides resources to "equity capital" with a goal of aiding or growing manufacturing, and while the goal of leveraging private funds with public dollars is worth exploring – it must be a careful path or federal dollars will harm U.S. workers. The union has seen private equity undermine workers' rights, and undermine economic security of local communities. For example, Ampad a paper company which was taken over by Private Equity investor Bain Capital, was loaded up with unnecessary debt, workers lost their pensions, and forced to re-apply for the jobs that many had worked at for decades because of a new owner.[6] To better understand these concerns it is helpful to reference the Center for Economic and Policy Research Co-Director Eileen Appelbaum who testified at the Senate Committee on Banking, Housing, and Urban Affairs Subcommittee on Economic Policy in October of 2021, "Private equity is poised to buy up broad swathes of the U.S. economy with no limit on how much debt they lever on the company, no limit on how much wealth they can take out, and no limit on how hard they can squeeze the employees. A study examining private equity buyouts of private companies found that when private equity takes these companies private employment declines by 13% in just the first two years".[7]

As the Energy and Commerce Committee and the House of Representatives look to address U.S. competitiveness in a host of policy arenas, the USW wants to

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[5] https://www.nlrb.gov/guidance/key-reference-materials/national-labor-relations-act
[6] https://abcnews.go.com/blogs/politics/2012/05/what-bain-capital-left-out-of-its-ampad-defense
[7] https://www.youtube.com/watch?v=LPV_a_wT6FY&t=4355s

ensure that precious taxpayer dollars are used effectively and do not lead to unnecessary job loss or low wage job creation.

U.S. – EU 232 Steel and Aluminum Arrangement

As the largest union in the steel and aluminum sector, our union has a significant interest in ensuring the long-term viability of the domestic industry. Steel and aluminum workers have faced a decades-long onslaught of excess capacity and state directed production which undermined national security in products that are vital to defense, critical materials, and infrastructure. These are just a few reasons why our union supported the section 232 investigations on steel and aluminum products and why we've supported strategic efforts to better manage trade in these commodities.

The recent arrangement between the U.S. and the EU on steel and aluminum is a good example of how the Biden Administration navigated international policy waters to reduce trade tensions and get better commitments to tackle overcapacity issues and greenhouse gas issues in these sectors.

The USW and our employers worked with the Administration to secure a deal which holds EU steel import volume levels below historic norms through a tariff rate quota (TRQ). A TRQ will allow the domestic industry to continue to operate at high levels, while allowing downstream consumers access to allied production. The arrangement also requires that EU steel imports be "melted-and-poured" in Europe. This is a recognition that semi-finished steel not produced in the U.S. or EU had the potential of seeping through the arrangement and will bolster EU and U.S. steel production. For the next 24 months, the U.S. and the EU will discuss overcapacity issues and climate related issues in this sector as well.

As the U.S. and the EU are the least carbon intensive steel regions in the world, the USW looks forward to working with our industry partners and governments, both in the U.S. and EU, to ensure that we create a high-water mark for steel policy in the twenty-first century that will expand domestic employment, reduce greenhouse gas emissions, and create good jobs.

Ensuring Resiliency

Resiliency is also particularly important to having secure domestic supply chains. Global supply chains are currently struggling to recover from COVID, but there is the possibility of other interruptions, like from extreme weather events.
For example, members of our union have been impacted by the semiconductor shortage this year. USW Local 105 at Arconic in Davenport, Iowa and USW Local 9231 at Cleveland Cliffs in New Carlisle, Indiana both supply the auto industry and

have had slow-downs of their work because the auto industry's production has slowed due to the semiconductor shortage.[8]

Policymakers should be working to develop redundancies and localize as much as possible to prevent untenable delays.

Conclusion

The transition of the U.S. and global economy to a clean energy economy is not one that everyone is looking forward to. American manufacturing workers have a great deal of skepticism about what this will mean for them, their jobs, and their communities. That skepticism is well founded after so many decades of policy-making have left manufacturing communities hollowed out.

But that regrettable history does not have to continue into the future. For this transition to be successful, manufacturing workers and their communities must be the leaders of this transition, not the victims of it.

Our union thanks you again for holding this important hearing, and we look forward to working with you to make our vision a reality for manufacturing workers.

[8] https://www.usw.org/blog/2021/americas-supply-chain-crisis

Mr. TONKO. Thank you, Ms. Brown. And now we move to Dr. Switzer.

Again, welcome, and you are recognized for 5 minutes, please.

STATEMENT OF JACKSON SWITZER

Dr. SWITZER. Thank you. Chairmen Rush and Tonko, Ranking Members McKinley and Upton, members of the House Energy and Commerce Subcommittees on Energy, Environment, and Climate Change, thank you for the invitation to testify at today's hearing.

My name is Jackson Switzer. I am the senior director for business development at Redwood Materials. Prior to joining Redwood, I spent over seven years at Albemarle Corporation, the world's largest lithium mining and refining company. I have a technical background, with a doctorate in chemical engineering from Georgia Tech, and a bachelor's degree in chemistry from the University of Alabama.

Representative Scalise, I don't see you here, and no offense to your alma mater, but Roll Tide.

Redwood Materials was founded by Tesla co-founder and longtime chief technology officer, JB Straubel, in 2017. JB founded Redwood to transform the battery supply chain, making it more sustainable, faster, and less costly. We aim to do this by offering large-scale domestic sources of battery materials that can go directly to U.S. battery manufacturers, like our partners, Panasonic and Ford. Our battery materials will be produced from recycled batteries, augmented with sustainably-mined material.

By 2030, Redwood intends to produce enough material to supply over six million electric vehicles, annually. We feel that quickly ramping a domestic battery material supply chain, using the highest possible percent of local, recycled raw materials, is the best way we can help meet the U.S.'s clean energy goals.

As Ethan at Bloomberg highlighted, our world is rapidly transitioning to electric vehicles. EVs are projected to account for nearly 100 percent of new cars sold in 2040. Ford, General Motors, and Stellantis have each made declarations to go all-in on electrifying their fleets over the next decade. And EV manufacturers Tesla and Rivian plan to exponentially ramp production. This expanding demand for EVs presents an opportunity for the U.S. economy, particularly the automotive sector, which accounts for roughly three percent of our nation's GDP.

Building out domestic EV battery and materials manufacturing capabilities can help position our country as a competitive international player in the global automotive space. Central and critical to this is establishing U.S. leadership across the battery supply chain.

The two battery materials we are focused on at Redwood are cathode materials and copper foils, which together make up nearly 65 percent of the cost of a battery, and, therefore, have major consequences to EV manufacturing.

Cathode materials have a long and complex supply chain today that involves mining and refining metal ores on multiple continents. Often, these materials travel greater than 50,000 miles before reaching an EV in the U.S. In total, the U.S. cathode demand is expected to increase by 600 percent over the decade. If the sup-

ply chain is left as is, to keep pace the U.S. would need to import greater than 2 million tons of cathode materials through 2030. This also translates to a lost economic value of over $85 billion U.S.

However, there is tremendous opportunity to generate our own supply of these materials over time, here in the U.S. Cathode material elements like lithium, cobalt, and nickel are infinitely recyclable. Copper foil supply chain is similarly dominated by other countries, particularly by Chile, Peru, and China. If its supply chain is left as is, the U.S. would need to import greater than 800,000 metric tons of copper foil through 2030, with another lost of economic value of greater than $13 billion.

Interestingly, the U.S. currently exports about the same amount annually, 800,000 metric tons of copper scrap, to Asia each year. This actually presents a tremendous opportunity for copper foil manufacturing within our country, capturing a valuable resource that we are currently exporting. The supply chain localization opportunity here is enormous.

We are confident Redwood Materials can be part of the solution.

Look, the transportation to electric transportation and clean energy is coming. As a nation, we must ask ourselves if we want to create the infrastructure and jobs to support that shift here in the United States, or will we allow other nations to develop the manufacturing capacity overseas, as has happened with most of the clean energy economy to date. Redwood Materials is committed to localizing the battery material supply chain to the U.S., but we are just one of many innovative American companies developing cutting-edge technologies that support electrification.

Implementing the right policies now is critical to helping these companies drastically and quickly scale their production in America. Policies like the Battery Manufacturing and Recycling Grant Program, which was spearheaded by Representative Doyle, and included in the Bipartisan Infrastructure Investment and Jobs Act, will help launch innovative solutions to strengthen the supply chain. Reinstituting the 48C tax credits to support clean energy manufacturing, as proposed in the Build Back Better Act, will also help companies invest in the United States and create high-quality jobs.

In closing, creating a circular supply chain for electric vehicles and clean energy products in the United States is a win-win, allowing our country to counteract an important environmental risk, while creating economic security, tens of thousands of jobs, bolstering our supply chain, and ensuring that the billions of dollars that will be invested in the battery industry land here in the U.S.

Thank you to both subcommittees for holding this important hearing. I look forward to the discussion.

[The prepared statement of Dr. Switzer follows:]

Prepared Statement by Jackson Switzer, Senior Director, Redwood Materials

Before the House Committee on Energy and Commerce

Subcommittee on Energy and Subcommittee Environment and Climate Change

Securing America's Future: Supply Chain Solutions for a Clean Energy Economy

November 16, 2021

Chairmen Rush and Tonko, Ranking Members McKinley and Upton, members of the House Energy & Commerce Subcommittees on Energy, Environment and Climate Change, thank you for the invitation to testify at today's hearing.

My name is Jackson Switzer. I am the Senior Director for Business Development at Redwood Materials. I joined Redwood Materials a year and a half ago. Prior to joining Redwood, I spent over 7 years at Albemarle Corporation, the world's largest lithium mining and refining company, headquartered in North Carolina. I have a technical background, with a doctorate in chemical engineering from Georgia Tech and a bachelor's degree in chemistry from The University of Alabama. Additionally, I have a master's degree in strategic intelligence from the National Intelligence University here in Washington, DC and previously worked for the Department of Defense.

Redwood Materials was founded by Tesla Co-Founder and Chief Technology Officer, JB Straubel, in 2017 to create circular, domestic supply chains for electric vehicles and energy storage products, making them more sustainable and driving down the cost of their single most expensive component: batteries.

Today, two of the most critical and expensive components of lithium-ion batteries (the cathode and the anode) are produced via a convoluted supply chain based almost entirely in Asia. Redwood plans to transform the lithium-ion battery supply chain by offering large-scale domestic sources of these battery materials, produced from as many recycled batteries as available and augmented with sustainably-mined material. Quickly ramping a domestic battery materials supply chain and using the highest possible percent of local, recycled raw materials is the best way we can meet the U.S.'s electrification and clean energy goals.

The Electrification Opportunity

The world is rapidly transitioning to electric vehicles as a response to mitigating climate change, decreasing regional pollution, and capitalizing off continually improving electric vehicle (EV) performance and costs. EVs accounted for 5% of total new car sales in 2020 and are projected to account for 20% of total new car sales in 2025, 50% in 2030, and nearly all new cars sold in 2040.[1,2] American automobile manufacturers including Ford, General Motors, Stellantis, and others have each made declarations to go all-in on electrifying their fleet over the next decade and Tesla and Rivian plan to exponentially ramp their domestic EV production.[3]

As such, the demand for EVs in the United States is projected to skyrocket over the coming decade. Further, the U.S. Government has set ambitious plans to transform our nation by achieving carbon-pollution-free electricity by 2035 and economy-wide, net-zero emissions by 2050. President Biden's recent executive order calls for a national goal of 50% electric vehicle sales by 2030.

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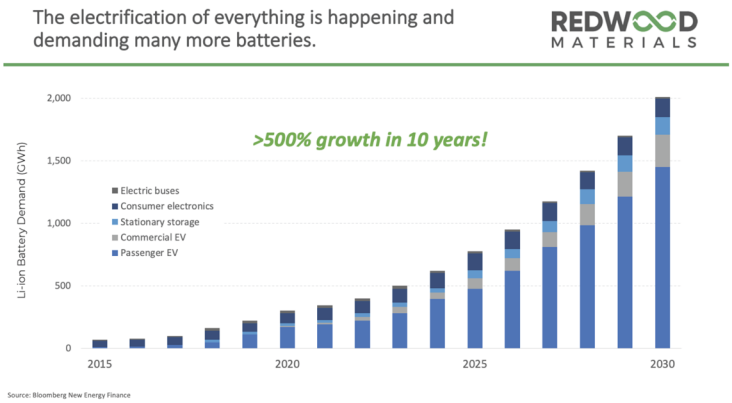
[1] *See* Rowlatt, J. (2021, June 1). *Why electric cars will take over sooner than you think.* Retrieved from BBC: https://www.bbc.com/news/business-57253947

[2] *See* UBS. (2021, March 3). *The electric vehicle revolution is shifting into overdrive.* Retrieved from UBS: https://www.ubs.com/global/en/investment-bank/in-focus/2021/electric-vehicle-revolution.html

This immense and expanding need for EVs presents a critical opportunity for the U.S. economy. The automotive sector has been a keystone of the U.S. economy, accounting for approximately 3% of our nation's GDP.[3] Building out domestic EV and lithium-ion battery manufacturing capabilities can help position the United States as a competitive international player in the global automotive manufacturing space and strengthen our nation's automotive sector as an increasing portion of cars transition to EVs.

Central to these goals is establishing U.S. leadership across the lithium-ion battery supply chain.[4]



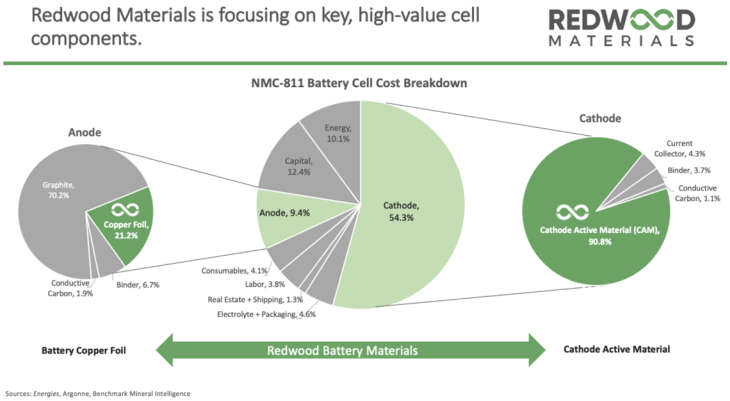
Building a Domestic Supply Chain

Redwood Materials is developing a fully closed-loop, domestic supply chain for lithium-ion battery materials. To close the loop and create a secure domestic supply chain, Redwood will (a) collect and recycle end-of-life lithium-ion batteries from consumer devices, electric vehicles, and energy storage systems, (b) refine the materials we recover, and (c) re-manufacture them into battery materials – specifically, cathode active materials and battery copper foils – that can go directly to U.S. battery manufactures, including our current publicly-announced partners like Panasonic and Ford.

Combined, cathode active material and copper foil make up nearly 65% of the cost of a battery. Integrated lithium-ion battery recycling and manufacturing of cathode active materials and battery copper foils is critical not only to reduce the costs of lithium-ion batteries but to secure our nations' environmental, sustainability, and geostrategic goals, as well.

[3] *See* Forbes. (2021, October 4). *Every Automaker's EV Plans Through 2035 And Beyond.* Retrieved from Forbes: https://www.forbes.com/wheels/news/automaker-ev-plans/
[4] *See* Federal Consortium for Advanced Batteries, *Executive Summary National Blueprint for Lithium Batteries* (2021).

Accomplishing this will transform the lithium-ion battery supply chain by offering, for the first time, large-scale sources of domestic cathode active materials and battery copper foils to U.S.-based battery manufacturing partners. These materials, which are critical for the manufacture of lithium-ion batteries, will be produced from recycled batteries and materials. Increasing our nation's production of these resources will serve as a key enabler to decrease the products' environmental footprint and scale-up U.S. manufacturing of lithium-ion batteries. In turn, this will increase domestic production of electric vehicles and decrease our foreign reliance. Creating a comprehensive component supply chain for EV manufacturing in the United States will fuel both technology development and the local monetization for domestically-developed technologies.



Cathode Active Materials

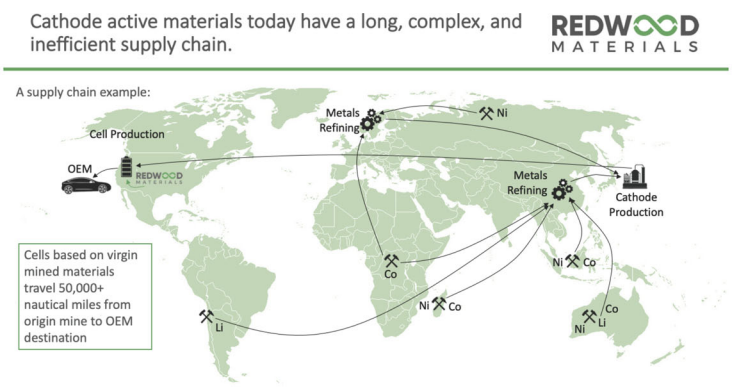
Cathode active material demand growth is following battery demand growth and is expected to increase by 600% over the decade in the United States, from roughly 50,000 MT in 2020 to nearly 450,000 MT by 2030.

Cathode active materials have a long and complex supply chain. The supply chain typically involves mining and refining metal ores on multiple continents, manufacturing cathode precursors, and the final production of cathode active materials. Batteries based on virgin mined materials typically travel over 50,000 nautical miles before reaching an electric vehicle in the United States.

Further, cathode active materials, present in most EVs today, typically contain greater than 30% nickel, 7% cobalt, and 7% lithium. These minerals come from mining today in diverse, and sometimes complex, places. However, there is tremendous opportunity to recover and recycle these elements, as they are infinitely reusable.

Today, finished cathode active material is imported into the U.S. today from Asia for local integration into batteries. **To keep plans with EV plans domestically, the U.S. would need to import greater than 2,000,000 MT of cathode active material through 2030 with a lost economic value of greater than 85 billion USD.**[5]

[5] Redwood Materials conducted its own internal analysis.



Battery Copper Foil

Lithium-ion battery manufacturing capacity, and the resulting demand for battery copper foil, is projected to skyrocket worldwide over the coming decade. The United States is projected to see a 600% increase in battery copper foil demand from 2020 to 2030.[6]

Both the production and mining of battery copper foil is currently dominated by other countries. Copper raw materials are predominantly mined in Chile, Peru, and China, while production occurs in China, Japan, and South Korea. Together, Chile and Peru control a larger share of this critical market than OPEC+ does of oil. China imports copper concentrate from both Chile and Peru, refining nearly 40% of the global supply.[7]

Finished foils are imported into the U.S. for local integration into batteries. **To keep pace with the announced EV plans domestically, the U.S. would need to import greater than 800,000 MT of copper foil through 2030 with a lost economic value of greater than 13 billion USD.**[8] To establish secure and robust battery supply chains and manufacturing capabilities capable of meeting our nation's rapidly growing demand, it is imperative that copper foil production within the United States expands.

In addition to enabling technology leadership across the battery supply chain and driving down costs, **U.S.-based copper foil manufacturing presents an opportunity for utilizing the greater than 800,000 metric tons of scrap copper that the U.S. exports to Asia every year.**

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[6] *See* Melin, H. E. (2021). Batteries Placed on the Market: Latest Update: 1 August, 2021. London, UK: Circular Energy Storage. Redwood Materials also conducted its own internal analysis.
[7] *See* Els, F., *Copper mining is Opec on crack, so why is the price falling?*, Mining, (July 13, 2021), https://www.mining.com/copper-mining-is-opec-on-crack-why-is-the-price-falling/.
[8] Redwood Materials conducted its own internal analysis.

A Domestic Manufacturing Base

Redwood Materials plans to build U.S.-based production facilities for cathode active materials and battery copper foils. By producing critical battery materials domestically at scale, Redwood will help decouple U.S.-based battery production from a shock-prone international supply chain, enabling the growth of reliable, large-scale U.S.-based cell production. In addition, the proximity will enable faster cycles of learning between battery makers and Redwood Materials, resulting in faster and meaningful technology and cost improvements.

In production facilities based in the United States, Redwood Materials will manufacture 100 GWh of cathode active materials and battery copper foil by 2025, enough for about 1.3 million long range electric vehicles a year. By 2030, Redwood intends to increase production of both materials to 500 GWh, enough material to supply over 6 million electric vehicles.

By producing battery materials domestically through processes that convert waste products into feedstock, Redwood Materials will help drive electrification of the U.S. economy and put our nation on the path towards net-zero emissions through domestic, sustainable manufacturing.

The construction of a domestic supply chain will help capture greater than 100 billion USD of economic value through 2030 that will otherwise be lost if we leave battery materials manufacturing to others abroad.

A Policy Opportunity

The transition to electric transportation and clean energy is coming. As a nation we must ask ourselves if we want to create the infrastructure and jobs to support that shift here in the United States or allow other nations to develop the manufacturing capacity overseas, as has happened with the clean energy economy to date.

Redwood is committed to localizing this supply chain in the U.S., but we're just one of many innovative, American companies developing cutting-edge technologies to produce advanced batteries. In the next few years, these companies will need to decide whether to invest billions of dollars to establish manufacturing hubs, either here or abroad. Implementing the right policies today can help these companies drastically scale their production in America to meet this moment.

Policies like the Battery Manufacturing and Recycling Grant program, which was spearheaded by Representative Doyle and included in the Bipartisan Infrastructure Investment and Jobs Act, will help launch innovative solutions to address the supply chain. Other proposals, like reinstituting the 48C tax credit to support clean energy manufacturing, as proposed in the Build Back Better Act, would also help companies invest in the United States and create thousands of high-quality jobs.

Creating a circular supply chain for electric vehicles and clean energy products in the United States is a win-win, allowing the country to counteract an important environmental risk, while creating economic security, tens of thousands of jobs, bolstering our supply chain and ensuring that the billions of dollars that will be invested in the battery industry happens here in the US.

I thank both Subcommittees for holding this important hearing and look forward to the discussion.

Jackson Switzer
Redwood Materials

Mr. TONKO. Thank you, Dr. Switzer.

We now move to Mr. Pugliaresi.

Welcome, and you are recognized for 5 minutes, please.

STATEMENT OF LUCIAN PUGLIARESI

Mr. PUGLIARESI. Thank you, Chairman Tonko, Chairman Rush, Chairman Pallone, Ranking Members McKinley, Rodgers, and Upton. I very much appreciate this opportunity to give my views on today's topic.

My name is Lucian Pugliaresi. I am president of the Energy Policy Research Foundation. I have personally worked on a broad range of energy security issues, both in and out of government, since the 1973-74 Arab oil embargo.

I would like to make just a few brief points to summarize my testimony. I hope the members will get a chance to look at some of the figures we put together there.

The energy system is highly complex. It is interconnected regionally and globally in ways that are not always apparent. The transition presents a new set of supply and price risks for consumers and manufacturers.

Achieving net zero in the developed world—I am talking about the OECD—is a prodigious and, actually, unlikely task. And even if we do that, we will only eliminate 20 percent of global emissions, versus a range of business-as-usual forecasts for 2050. It is—everything is about the developing world: Asia-Pacific, Africa.

Regulatory programs, as well as private-sector commitments to accelerate the energy transition, whether it is mandates, targets, financial, or Federal procurement guidelines, create uncertainty and financial risks that will limit needed investments in a broad range of legacy fuels, particularly oil and gas.

While most of the escalation in energy prices can be tied to dislocations in oil and gas supply chains, largely from the COVID pandemic, recently-announced policy decisions, such as the halt on leasing on Federal lands, the cancellation of the Keystone Pipeline, the potential cancellation of Line 5 and bringing Canadian crude oil to the United States, rising regulatory requirements, and permitting delays are all threatening North American oil and gas production. We undermine this strategic asset at our peril.

Oil and gas production is going to be needed throughout the transition. Today, after government support, we have put tens of billions of dollars into wind and solar. But if you look at its contribution to primary energy supply in the U.S., it only represents four percent. In fact, wind and solar today still require vast sums of Federal support in the form of production tax credits. And today, the oil and gas development in the U.S. still generates large revenues to the Federal Government. This is the fundamentals of the marketplace. This doesn't represent the values of these two fuels, it just tells us how society values these two technologies.

The current energy crisis in Europe is a cautionary tale, and we should learn from it. I have my colleague from London here with me today, and he has been briefing us on the situation there. The European crisis has its roots in policies that sought rapid decarbonization without accounting for the associated supply risks.

Policy initiatives which seek to accelerate the U.S. transition to a fully renewable energy complex before these technologies are cost effective will have global implications. And we are going to cede our energy security to China, Russia, and the Middle East. They will all gain positional advantage if we don't do this right.

The transition will create unprecedented new demands, and add new energy security threats to existing ones. We are, essentially, trading a secure, independent energy complex for one with new and poorly-understood risks. I recommend you look—we issued a chart of the week by one of our senior researchers, Max Pyziur, and there is an interesting statistic in there: a smart battery phone uses three grams of lithium, a Tesla uses 140 pounds. Think about the requirements, as we accelerate electric vehicles in the U.S.

Investment and adaptation should be part of our discussion, going forward.

And finally, and most importantly, policy measures should be robust against uncertainty. We have a long list of things we have done with Congress and past administrations, which sounded like a good idea at the time. But the world changed. So one of the things I hope the committee will take under consideration, however we proceed with these measures, that we think about strategies that hold up against a broad range of uncertainties.

Thank you for your time.

[The prepared statement of Mr. Pugliaresi follows:]

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Testimony
of

Lucian Pugliaresi
President
Energy Policy Research Foundation, Inc. (EPRINC)

for the

Subcommittee on Environment and Climate Change
and the
Subcommittee on Energy

of the

U.S. House of Representatives Committee on Energy and Commerce

hearing on

"Securing America's Future: Supply Chain Solutions for a Clean Energy Economy"

November 16, 2021

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Chairman Tonko, Chairman Rush, Ranking Member McKinley, Ranking Member Upton, and members of the subcommittees, my name is Lucian Pugliaresi. I am President of the Energy Policy Research Foundation, Inc. (EPRINC), a non-profit public policy research organization. EPRINC was founded in 1944 and studies energy economics and policy issues with special emphasis on oil, natural gas, and petroleum product markets. I have worked on a broad range of energy security issues for my entire career, both in and out of government, beginning with the 1973-74 Arab oil embargo. Over the last two years EPRINC has been involved in the arduous task of understanding the limits of our ability to model energy futures.

I welcome this opportunity to provide my perspective on the tasks before us in addressing the supply chain challenges of a low carbon economy. As we proceed with a broad set of policy initiatives to implement the energy transition, we need to understand the full array of technical, economic and security uncertainties as well as the fundamental constraints that may disrupt the pace of this transition. Congress working with the Administration needs to put considerable effort in ensuring that transition policies remain robust against the full range of uncertainties and in a manner that sustains our security and economic well-being. Public support for the transition will hinge on the availability of reliable and affordable energy which remains the lifeblood of our economy and our national security.

The energy transition requires overcoming complex technical, scientific and public policy challenges. It is an enormous undertaking, fraught with setbacks, especially if attempted quickly without a careful assessment of the full range of economic and social consequences. I encourage the Congress to consider the following points as you proceed with legislation to accelerate the transition to the fuels and technologies of the future.

1. **The Energy System is highly complicated, inter-connected regionally and globally in ways that are not always apparent. The energy transition presents a new set of supply and price risks for consumers and manufacturers. Fully implementing an energy transition over the next 30 years is neither easy nor can it be assured.**

The tasks required in any transition will be enormous, difficult and expensive -- complicated by the fact that other countries around the world are attempting similar feats with little or no practical experience. Worldwide, fossil fuels continue to dominate the energy complex, providing over 80 percent of primary energy requirements (Figure 1). This will not be our first attempt to accelerate the energy transition and Figure 2 demonstrates how difficult it remains to implement

ambitious plans to accelerate the deployment of wind and solar resources to support the energy transition. The deployment of these technologies have been limited even as the U.S. government has provided direct financial incentives and mandates to advance wind and solar power over the last 30 years (over $50 billion in federal expenditures in tax incentives and grants between 2005-2015 alone).[1] Today, these two technologies produce less than 4% of our primary energy requirements. In the same time period (2005-2015), gross receipts to the federal government from oil and gas leasing exceeded $110 billion.[2] Oil and gas continues to garner revenues for the federal government, a considerable portion of which is shared with the states. The differences in these two revenue streams (one from, and other to, the federal government) reflect the reality of the marketplace.

2. **Achieving net zero in the developed world will reduce carbon emissions by only a small amount, likely no more than 20 percent of expected global emissions.**

Reducing carbon emissions is a global challenge. Even if the developed world achieves net zero, our research concludes that without a massive commitment from the developing world, the net reduction in carbon emissions will be relatively small, perhaps no more than 20% less in 2050 when compared to a business-as-usual scenario (Figure 3). An important challenge for the developed world, represented by membership in the Organization for Economic Cooperation and Development (OECD), is that policies that push for a rapid energy transition will also likely be accompanied by lower rates of economic growth. This is a serious challenge for the OECD as any loss of economic expansion will also reduce public resources for research and development of new and advanced carbon free energy resources.

3. **Regulatory programs as well as private sector commitments to accelerate the energy transition – whether it be mandates, targets, financial and procurement guidelines create uncertainty and financial**

---

[1] *Examination of Federal Financial Assistance in the Renewable Energy Market*, November 2018.https://www.energy.gov/ne/downloads/report-examination-federal-financial-assistance-renewable-energy-market

[2] *Options for Increasing Federal Income from Crude Oil and Natural Gas on Federal Lands. Congressional Budget Office,* April 2016. https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51421-oil_and_gas_options-OneCol-3.pdf

risks that limit investment commitments to current legacy fuels, many of which are likely to remain in demand for years to come.

Legislative, regulatory and policy decisions made today, even if relatively narrow in scope are creating expectations of rising costs and delays in extraction of oil and gas resources, and increasing the risk for capital flows to establish new oil and gas production. For example, policies by financial institutions that prohibit investments in the development of oil and gas resources may lead to temporary if not longer-term supply constraints that will affect energy prices, manufacturing and US competitiveness.

Many commentators assert that there remains a serious risk that oil and gas companies are likely to end up owning assets for which there is no market, but financial data does not support the claim that companies are holding "stranded assets" (Figure 4), nor is it likely that world demand for oil and gas will decline precipitously in the near future. Our desire for change cannot obscure the on-the-ground reality of how important energy is to our economy and the need to assure a robust supply of reliable and affordable energy.

4. **Most of the recent escalation in energy prices can be tied directly to dislocations in energy supplies (largely oil and gas) from the Covid-19 pandemic. However, government policies, such as the halt on leasing on federal lands, the cancellation of the Keystone Pipeline, the potential cancellation of line 5 from Canada, rising regulatory requirements and permitting delays are all threatening North American oil and gas production. We undermine this strategic asset at our peril if we abandon these fuels before the energy transition is well established.**

The U.S. and the rest of the world will continue to need oil and gas throughout the transition. Any policy decision based on the simple premise that the U.S. can transition simply by cutting off production of legacy fuels will backfire horribly and erode public support. Other measures under consideration, such as halting crude oil exports or a release of the Strategic Petroleum Reserve without a genuine supply disruption are likely to be counterproductive.

Recent speculation that some members of Congress and the Biden Administration are considering reinstituting a ban on U.S. crude oil exports is especially worrisome as it would likely raise gasoline prices and further disrupt supply chains. The U.S. is a large continental land mass and so minimizing transportation costs for moving crude oil to market are important. Oil prices are set in the world market so a refiner in Hawaii would rather purchase crude from Indonesia than

Houston and save on transportation costs. A Gulf coast refiner whose processing technology is tuned to heavy crude might find it cheaper to use Mexican or Canadian oil than one with alternative specifications produced in North Dakota.

Crude oil and petroleum product exports allow the entire North American production platform to minimize transportation and processing costs. Open access to markets and crude and product transportation efficiencies permit U.S. refineries to operate at high levels of capacity utilization and provides opportunities for upstream producers to maximize crude oil output. The free movement of capital, crude oil and petroleum products remain critical to sustaining the productive capacity of the U.S. petroleum industry and the entire North American oil and natural gas production platform. These efficiencies have led to rapid expansion of U.S. oil production and remain one of the central reasons that large volumes of U.S. crude imports also result in large volumes of higher value-added exports of petroleum products. One of the reasons the U.S. has achieved energy independence is that the production platform is efficient. Reinstituting the export ban would result in further reductions in U.S. production, higher stress on supply chains, and rising price risk to gasoline supplies.

5. **Policy Matters. The US should see the current energy crisis in Europe as a cautionary tale and learn from it.**

The current energy crisis in Europe, characterized by rapidly escalating natural gas prices, has been driven by constraints in electricity supplies. The European crisis has its roots in policies that sought rapid decarbonization without accounting for the associated supply risks. Germany presents a stark example as the rising demand for natural gas to support intermittent renewable supplies has contributed to a more expensive and a less resilient power sector (Figures 5 and 6). Clearly, recovery from the pandemic is a factor, but so are policies that limit fuel diversity and make power systems less resilient.

The German Commission on Growth, Structural Change and Employment, better known and referred at the Coal Commission set up by the German Government to enquire into the future of the role of coal (and lignite) in the country's low carbon energy transition released its strategy document in January 2019. The German transition strategy followed two previous policy instruments, the German Feed-In Tariff Law of 2000 and the German Nuclear Plant Shut down Directive of 2012. In early 2020, German government articulated its first draft of its Hydrogen Strategy that made a technology choice of hydrogen production through the electrolysis route over other more economically attractive technology options.

The German energy transition plan is now directed by these new policy instruments and despite support for the transition initiative by several leading figures (including the Head of the IEA, Dr Fatih Birol) these policy initiatives are delivering higher systemic risk into the German power sector.

Two risky features are now prevalent in the German power sector:

1. The transition to a low carbon economy in Germany - driven mainly by policy instruments around highly attractive feed-in tariffs for renewables, a shut-down of coal and nuclear plants by 2024 and 2038 respectively and the introduction of hydrogen by a specifically chosen technology route. These policy initiatives will not be sufficient to meet demand for electricity in Germany in 2030. The energy transition in Germany has been a policy driven exercise that has been expensive and yet unable to achieve its stated aims.

2. The only remaining fuel vector for Germany to close the gap in its electricity demand then remains natural gas/LNG.

These policy instruments, directed at rapidly bringing down carbon emissions will continue to be expensive, unable to meet its stated decarbonization targets and drive rising, instead of reduced, demand for natural gas.

6. **Policy initiatives that seek to accelerate the U.S. to a fully renewable energy complex will have global implications for energy security.**

Much of the world will remain dependent on oil and gas with a growing dependence on producers from the Middle East and Russia. Recent trends in upstream oil and gas capital expenditures are especially worrisome (Figure 7). While the reluctance to increase capital expenditures among the major oil companies may be tied to concerns on strengthening their balance sheets, rising development costs, other forces may be at play as well including government directives discouraging investment by financial institutions in upstream oil and gas development. Should this trend continue, we might find ourselves in the midst of a two-speed transition process. Rapid transition (at least an attempted rapid transition) in the OECD, but limited progress in the developing world. China, Russia and the Middle East will gain positional advantage leaving the U.S. and its allies vulnerable to strategic threats. We may end up with an energy transition which will see the U.S. move from our current position of energy independence to dependence on a broad set of critical minerals from insecure sources, while at the same time experiencing growing reliance on traditional oil and gas supplies from insecure and expensive sources.

7. The transition will establish new environmental challenges and energy security issues in addition to the old.

Figures 8, 9, and 10 show the challenges facing the U.S. Today, the U.S. is the largest producer of oil and gas worldwide. This provides strategic advantages and energy independence. A rapid shift to reliance on electric vehicles (and batteries), solar, wind and related renewable energy sources will also require large quantities of copper, lithium, manganese, cobalt, and molybdenum. While many of these minerals can be developed through potential mining sites in the U.S., these minerals will also require new processing facilities to be developed into useable materials. Permitting constraints and environmental reviews will likely make the development of these resources a long and arduous effort.

In addition, it is not a trivial effort to construct large scale wind and solar farms and to accelerate the production of electric vehicles. Mark Mills, Senior Fellow at the Manhattan Institute, has outlined the formidable requirements for replacing the energy output from a single 100 megawatt natural gas-fired turbine with wind turbines.

> *It would require at least 20 wind turbines, each one about the size of the Washington Monument, occupying some 10 square miles of land. Building those wind machines consumes enormous quantities of conventional materials, including concrete, steel, and fiberglass, along with less common materials, including 'rare earth' elements such as dysprosium…. All forms of green energy require roughly comparable quantities of materials in order to build machines that capture nature's flows: sun, wind, and water. Wind farms come close to matching hydro dams in material consumption, and solar farms outstrip both. In all three cases, the largest share of the tonnage is found in conventional materials like concrete, steel, and glass. Compared with a natural gas power plant, all three require at least 10 times as many total tons mined, moved, and converted into machines to deliver the same quantity of energy.*[3]

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[3] Mills, M. P. (2020, July 9). *Green Energy Reality Check: It's not as clean as you think*. Manhattan Institute. https://www.manhattan-institute.org/mines-minerals-and-green-energy-reality-check Page 6

8. **Policy measures should be robust against uncertainty**.

We are heading into a largely uncharted world full of enormous, price, energy security risks. We have an extraordinary responsibility to consider the vast and array of risks and to develop policies that are robust under the uncertainties that cannot be easily predicted. Expect failures, cost over-runs and the unexpected. As shown in Figure 11, experienced analysts with long experience in modeling our future of energy requirements disagree on worldwide requirements over the next 30 years.

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FIGURE 1
Energy Transition is Hard and Rare

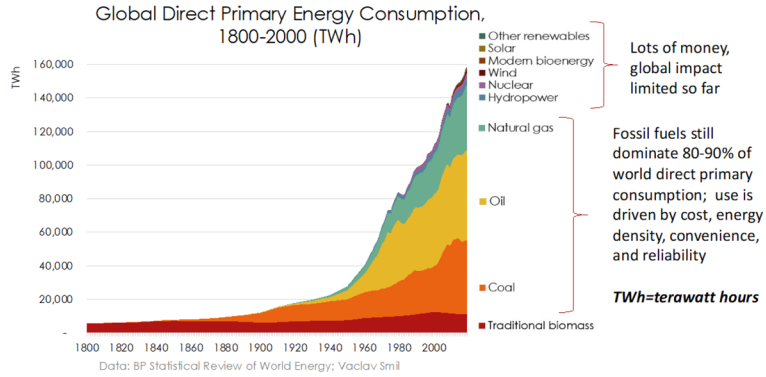


FIGURE 2
Ambitious Goals Need Sober Assessment

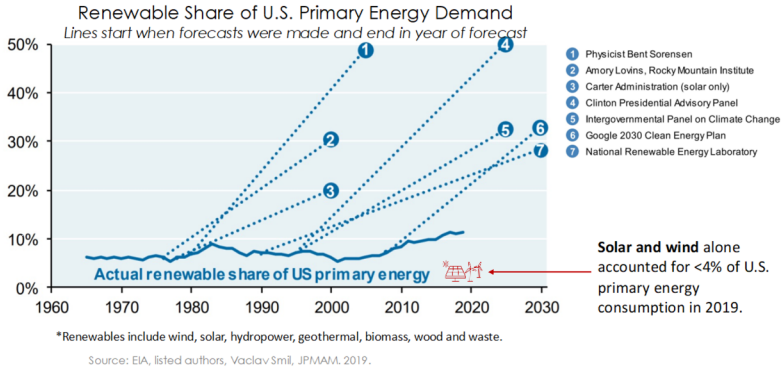
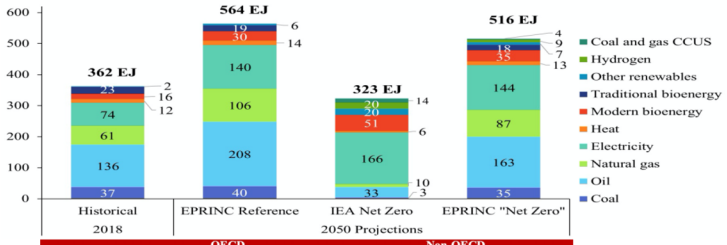


FIGURE 3

EPRINC's Optimistic Scenario Still Falls Short of Net Zero (Exajoules)

(Industry, Buildings, and Transport)



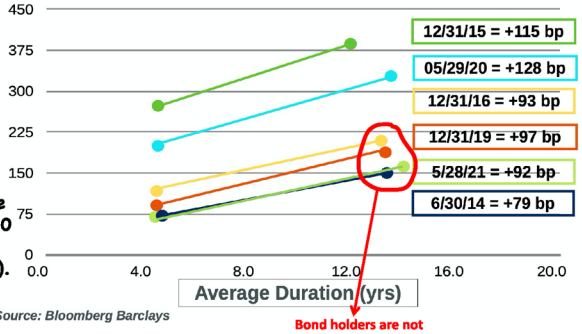
	OECD	Non-OECD
Power	Renewables replace **100%** of coal and **75%** of natural gas	Renewables replace **10%** of coal and **10%** of natural gas
Buildings	Increased building efficiency reduces **50%** of all fuels	Increased building efficiency reduces **10%** of all fuels
Industry	Increased efficiency and new processes replace **25%** of all fuels	Increased efficiency and new processes replace **10%** of all fuels
Transport	Electric vehicles replace **50%** of internal combustion engine (ICE) highway miles	Electric vehicles replace **10%** of internal combustion engine (ICE) highway miles

FIGURE 4

Stranded Assets?

Risk Averse Long Dated Investment Grade Bondholders Like Oil & Gas

Since the shale-related reset of world oil prices that began in mid-2014, the IG energy credit spread curve has not steepened meaningfully, other than temporary spikes caused by oil price volatility (mainly the 2020 pandemic and related OPEC+ market share war).



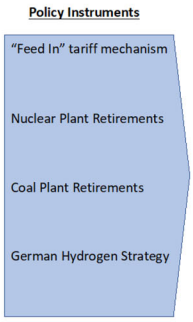
Source: Bloomberg Barclays

Bond holders are not buying into stranded assets, yield curve is not rising steeply

Source: Paul Tice, Stern Shool of Business, NYU; EPRINC Chart of the Week

FIGURE 5

GERMAN ENERGY TRANSITION DIFFICULTIES ARE 'POLICY DRIVEN'



Stated Aim/Objective of the Policy

Introduced in 2000, this policy guaranteed high tariffs for early investors which produced a solar boom.

Following the Fukushima Accident, Germany was the first country to ban all future nuclear power and enforce a shutdown of its nuclear fleet by 2022

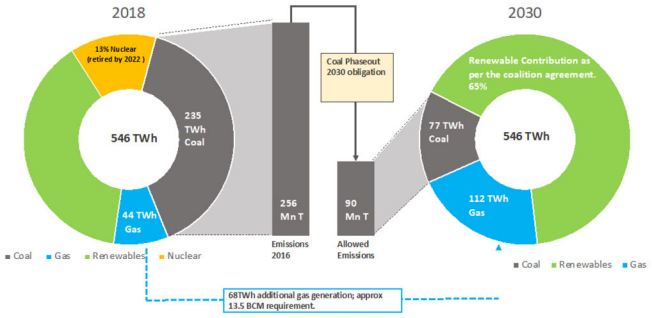
The "Coal Commission" policy proposals advocate a retirement of entire 45GW coal capacity by 2038

The Hydrogen policy seeks to utilise the renewable overcapacity for hydrogen production through promoting commercial scale electrolysers- a technology choice made by policy, ignoring the cost-competitiveness of hydrogen production through the natural gas steam reformation route.

Source: Ash Shastri, EPRINC Distinguished Fellow

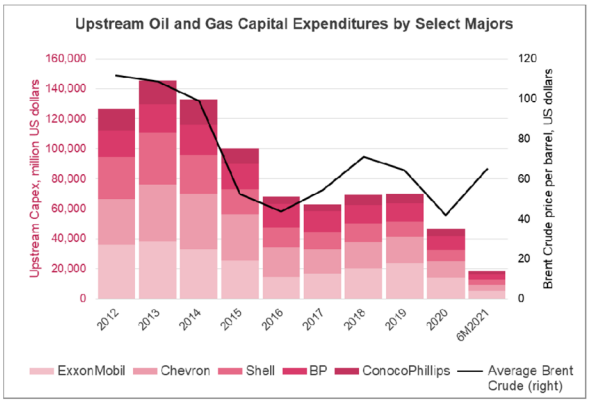
FIGURE 6

GERMAN ENERGY TRANSITION PLANS FORESEE A SIGNIFICANT ROLE FOR RENEWABLES BUT GAS WILL STILL REMAIN A CRITICAL FUEL BEYOND 2030



Source: Coal Commission Documents, Press Reports, Fraunhofer Charts and EPRINC Team Analysis

FIGURE 7

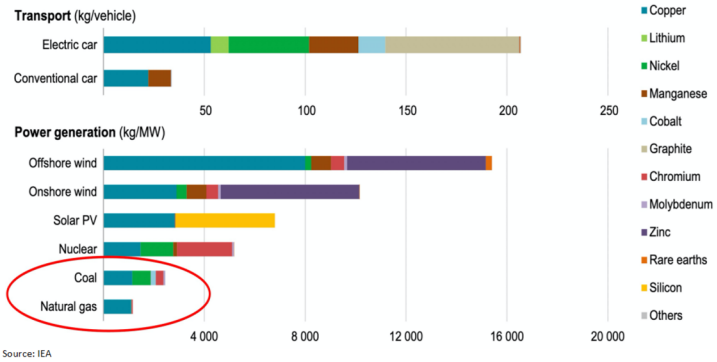


Source: Battulga Odgerel, EPRINC; Data: Company SEC filings, EIA historical pricing data

Annual financial reports from some of the major oil and gas companies show that despite growing oil prices, upstream capital expenditures continue to remain low, exacerbating the already tight market and contributing to a prolonged price rally in the coming years.

Figure 8

Energy Transition Will Require Acquisition of Higher Volumes & Broad Range of Minerals

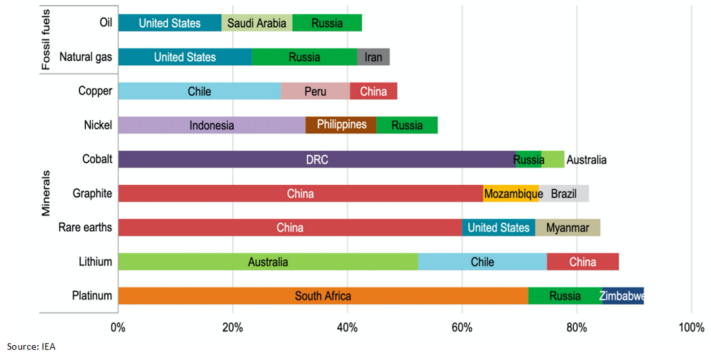


Source: IEA

FIGURE 9

The U.S. is a Leader in Oil and Gas Production

(In specialty minerals, U.S. is highly dependent on foreign sources of supply)



Source: IEA

Figure 10

Is this the new Energy Security Problem?

Rare earth mine production (metric tons), 2019, 2020

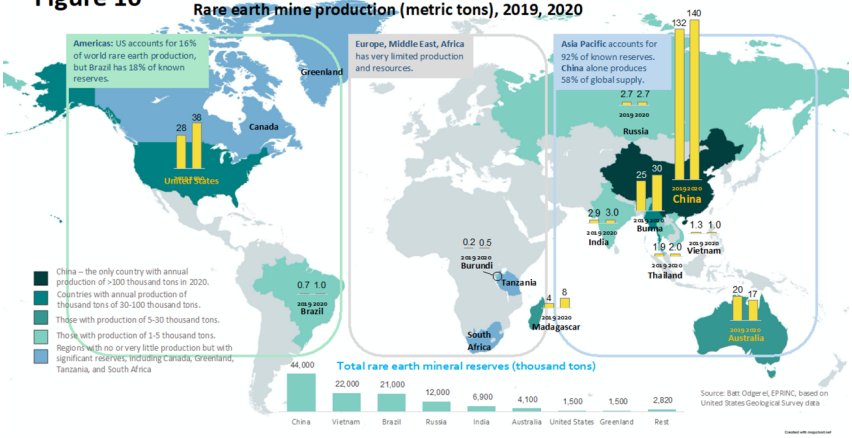
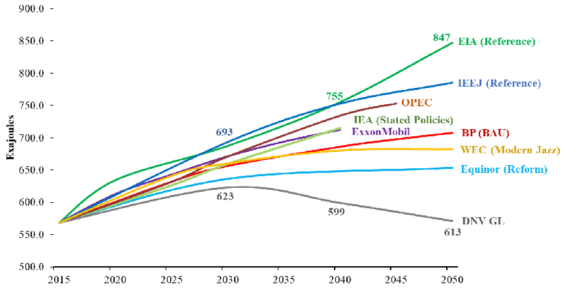


Figure 11
Recent Primary Energy Supply Scenarios to 2050 (Exajoules)

There are wide differences in energy outlooks?



Note: Exajoule (EJ) is a comprehensive unit of energy, roughly equivalent to 1.05 quadrillion British thermal units (quads). One EJ equals 10^{18} (one quintillion) joules, and one joule equals the amount of work done on a body by a 1 Newton force that moves the body over 1 meter. One exajoule per year = 447,000 barrels of oil equivalent per day.
Source: EPRINC, compiled from industry and think tank reports

Mr. TONKO. Thank you very much, Mr. Pugliaresi.

We now move to member questions, and I will start by recognizing myself for 5 minutes.

When we discuss clean energy goals, they can often be difficult to wrap our heads around. But Mr. Zindler, I am hoping you can help give us a better sense of the scale of our national, or even global energy transition. Can you give us any estimates on how much investment is required, necessary to achieve an ambitious emissions reduction goal?

[Pause.]

Mr. TONKO. Can you activate your mike? Thanks.

[Pause.]

Mr. TONKO. No.

[Pause.]

Mr. TONKO. Thank you. Ms. Brown to the rescue.

Mr. ZINDLER [continue]. Ms. Brown for a minute.

The—first, just a comment, I—if I could just make one quick comment, which is that I heard a lot about—talking about how this is some kind of a rush, that we are—that this is a policy that is a rush. Only here in the U.S. is this viewed as a rush.

There are ten countries already which get more than 25 percent of their power from wind and solar today, and these are not tiny countries. There are countries like UK and Spain and Portugal and Germany. They have already—or Uruguay. They are not all in Europe, where we have seen this kind of transition already underway. So there is nothing particularly, actually, new. If anything, we are well behind on a transition that is taking place around the globe.

We have been seeing about 500 billion—Mr. Chairman, to your question—we have been seeing about $500 billion a year invested in what we would call energy transition technologies, overall. That number, basically, has to double to start to get where we need to go, in terms of trying to achieve some of the net-zero targets that have been declared.

Mr. TONKO. Thank you. And can you give us a sense of what that means, in terms of manufacturing, or critical mineral needs?

Like, how many more solar panels, wind turbines, and batteries are necessary, are needed in a world where those targets are achieved?

Mr. ZINDLER. Well, I mean, we have been consistently seeing the demand for solar rise each year, anywhere from 10 to 20 percent, depending on which year you are talking about, mainly because the technologies, I would point out, are, in many parts of the world right now, the lowest-cost option. And that is, really, what is proliferating a lot of the growth.

So we expect, for the U.S. to try and hit its clean energy goals, the ones that have been declared, to try and get to zero percent carbon by 2035, we need to go from building about 40 gigawatts a year to building about 80 per year in the United States, which mean about a, roughly, doubling in the investment in the short run, but, obviously, the costs have been coming down, so that will reduce that somewhat.

Mr. TONKO. Thank you. And based on today's testimony, it seems, for at least some technologies and components, are not currently U.S. firms positioned to fully take advantage of these mas-

sive emerging markets (sic). The Build Back Better Act would help change that. Any comments about what might be inspirational with the Build Back Better Act?

Mr. ZINDLER. So, I mean, for our work that we did for the Center for Strategic and International Studies, we tried to look at some of the successful industrial policies in other parts of the world.

And as I noted in my testimony, China—you—any one of these sectors, but if you—particularly, we looked at the electric vehicle sector about ten years ago—put together a plan in which they determined that they wanted to be the world's largest producer of electric vehicles, and the largest consumer of them, as well. And they set about creating both supply and demand-side policies to support that.

We do not have long-term certainty at the moment about what the demand for electric vehicles will be, just to give one example. The corporate average fuel economy standards, which are certainly being, you know, are—have been revised, but are constantly being challenged, provide some additional certainty to automakers. And we have certainly seen these declarations from Stellantis, from Ford, from GM that they plan to do EVs.

But I would say that, if you were to press them, many of them would not say that the U.S. is the primary market that they think will be the demand market, because there is a lot more certainty from Europe and other parts of the world.

Mr. TONKO. Thank you. And I will move over to Ms. Brown now.

And when we talk about climate jobs, we often think about construction jobs being—building transmission lines, installing EV charging stations, or retrofitting buildings. Could you share for the subcommittees where you see the biggest opportunities for clean energy manufacturing jobs?

Ms. BROWN. Absolutely, and thank you so much for the question, Mr. Chairman.

You know, everywhere, in a nutshell, everywhere. When you think about the types of clean energy technologies that we are talking about, whether it is onshore or offshore wind, there is a significant amount of steel that is required for both of those technologies. If we are talking about solar, the glass that is needed for solar panels, the aluminum, the copper that is needed for solar panels, are all made by steelworker members. If we are talking about energy efficiency, manufacturing facilities won't only benefit from those technologies, but can actually make those technologies, and steelworker members actually make energy efficiency technologies.

So for us, it is—the possibilities are endless, and vast, and really stretch across each of these technologies, and I think we are just waiting to do the work.

Mr. TONKO. Thank you so much. We will now recognize Mr. McKinley, Subcommittee on Environment and Climate Change ranking member.

And Representative McKinley, you are recognized for 5 minutes for your questions.

Mr. MCKINLEY. Thank you and thank you, again, Mr. Chairman, and thank you for the panel. It is interesting to see, you know, some of the perspectives, and we could learn from this. But I would like to address my questions primarily to Mr. Pugliaresi.

Mr. PUGLIARESI. Pugliaresi, yes.

Mr. MCKINLEY. Pugliaresi. And speaking for the Administration in Scotland, John Kerry said there that the United States should eliminate the use of coal by 2030, period. And he reinforced how other fossil fuels—oil, gas—would be eliminated by 2035. And as you point out in your testimony, that is going to result in an expedited shift to renewables in the next few years—we could do the count until 2030—and that is going to require large quantities of critical minerals.

But the U.S. still imports the vast majority of its mineral needs for renewables, and is entirely relying on foreign nations for some of them that I talked about in my opening statement. So do you believe that America will be able to supply itself the critical minerals needed by 2030 and by 2035?

Mr. PUGLIARESI. No one who——

Mr. MCKINLEY. Use your mike, please.

Mr. PUGLIARESI. Yes. No one who understands how we do permitting, how we go through the development, the NEPA reviews, believes that that is even possible. It is just not going to happen.

And in fact, I think the biggest—if you look—the biggest concern we have with the power sector is, if you push it too fast, it is going to become very brittle. It is going to become brittle because the fuels we use are going to be much more narrow, and we are going to be also subject to more complex systems, which are subject to failure modes that we don't even fully understand yet.

Mr. MCKINLEY. Thank you. The administration has been focused on this need to increase the domestic supply chain, and I think we have had a good dialogue, and we understand the need for that to be addressed for renewables. But that, as I pointed out in my opening remarks, that is going to require a lot—a significant increase in domestic mining, processing, and manufacturing. And we know that China, right now, is the lead firm—nation that processes the bulk of these renewables. And then they ship them around the country, around the world.

And we said before, the U.S. is going to need—to meet the demand, we are going to need 500 to 1,000 percent more minerals than we have today. So do you believe that the current permitting process will allow the United States to increase its domestic processing of critical minerals?

Mr. PUGLIARESI. You can bet that is not going to happen. You don't—I mean, it is—we have the process—look, you just look at the scale problems that we face. We have been working on wind and solar for 30 or 40 years, and we have had grandiose plans. But, as I pointed out, deploying it is something else. It still only represents four percent of primary energy.

Mr. MCKINLEY. Then why isn't Congress and the Administration—why aren't they listening to you?

We—if it can't happen, you——

Mr. PUGLIARESI. I actually——

Mr. MCKINLEY. I mean, seriously. You know, it is a—get out of this politics, and just the reality. I am a civil engineer, I am a licensed civil engineer. I deal in facts. I don't understand why we are letting emotion get into this, rather than the facts that you are pointing out.

We just simply can't get there now, and that was why I was making—in my opening remarks, saying, "Give us time, we are going to get there, but I would like to have this fossil fuel—the use of fossil fuels to bridge until we can get those things taken care of."

But in the meantime, we are dealing with—and then there is the last question I would like to ask, is having to do with critical minerals, again.

What are the labor and environmental benefits if we process these critical minerals in the United States, as compared to what they are doing in China and elsewhere?

How—because we have been concerned about environmental justice, and I have understood some of the components of that. But what are we doing now?

If we bring this back home, are we going to improve—and it should, hopefully, increase the environmental benefits by producing them here. Can you elaborate a little bit on that?

Mr. PUGLIARESI. Clearly, we have an enormous number of environmental standards that all industry has to adhere to. So the—from a global point of view, it will be produced in a much cleaner, responsible way.

And—but it also is going to require a scale. I think we really don't appreciate the scale of the problem before us. I mean, people talk about Denmark. There are five million people in Denmark. There are 300 million people in Indonesia, and they all want an air conditioner. And they don't want to spend a lot of money for their power. So the real dilemma for us is we have to have—we have to let our technology mature, so that it is cost effective, so that the American consumers don't see escalating costs as we try to wrench the system before the technology is ready to be deployed.

Mr. MCKINLEY. Mr. Pugliaresi, I can't agree with you more. Thank you for testifying here, and I yield back my time.

Mr. TONKO. The gentleman yields back. The Chair now recognizes Chairman Rush of the Subcommittee on Energy.

Chairman Rush, you are recognized for 5 minutes, please.

Mr. RUSH. Well, thank you, Mr. Chairman. One of the comments that struck me this morning, Mr. Chairman, was coming from Mr. Zindler, his testimony.

Mr. Zindler, you stated that the clean energy provisions of the Build Back Better Act, which this subcommittee—these subcommittees helped to write, stand to make the biggest impact in expanding the clean energy supply chain. Would you explain how passing the BBB will establish and grow the domestic clean energy supply chain?

Mr. ZINDLER. Thank you, Mr. Chairman, and, yes, I would be happy to respond to that.

But can I—I do want to just come back on a couple of things, a comment that has been made twice about wind and solar only providing four percent of primary energy in the United States. I will just state a basic fact. Wind and solar is used for electricity purposes. We don't put wind turbines on our cars. We get—energy is not just electricity. The electricity sector is 40 percent of our energy usage. So to say that it is only four percent of total energy is correct, but it is ten percent of power, and it was 0 percent, basically, 15 years ago, ten years ago, even. So I just want to clarify that,

because that is not really a fundamentally accurate way to depict this, unless someone here would like to put, you know, wind turbines on cars soon.

Now, to the question about what is in the Build Back Better legislation, I think what is critical in there is that it looks at this from both the supply and a demand side. I talked about the China example earlier. If you look at the support that the Build Back Better bill provides, it both provides incentives to consumers to buy EVs, it provides incentives—pardon, tax credits—for those to build wind and solar. But it also has supply-side supports in the form of tax credits for specific segments of the manufacturing value chain, overall, which will—which could help to ensure that, as the market scales, the manufacturing takes place more within the U.S. than it would elsewhere.

Mr. RUSH. Can you—Ms. Brown, can you talk about whether the United Steelworkers sees, in terms of the impact on job creation from a build-out of the clean energy supply chain, and could we see the—can you tell us again what is the expected impact that job creation for Black and Brown workers under the Build Back Better Act?

Ms. BROWN. Thank you for the question, Chairman Rush. I just want to actually echo something that Mr. Zindler said, in terms of just the tax pieces that are included in Build Back Better.

For the first time, there are actual requirements attached to clean energy taxes that, you know, make it a requirement to use and source domestically-produced materials for any clean energy projects. That is something that our union has been working really hard to do, really, since 2006, with the Production Tax Credit and the Investment Tax Credits. For the first time, we were able to work with the Senate Finance Committee to achieve that. That is huge.

I can't emphasize what a boon that is for the supply chain, when it comes to sourcing the iron, the steel, or the other manufactured goods, whether it is cement or other manufactured goods that go into these clean energy projects. That, if it is able to stick, is something that is critically important to Steelworker members.

The other thing that I will say is there is significant money in the BBB to repurpose brownfields, and a lot of the brownfields are in Black and Brown communities, to your question, Chairman Rush. And I want to point to a real-world example in Baltimore here, just up the street from us here, in Washington, D.C., on the former ground of the Bethlehem Steel Sparrows Point facility.

That was the Beast of the East. That is what our union used to call that facility. It employed 50,000 steel workers at one point, making steel. That facility closed in 2012. No more steel, basic steel, was made in the State of Maryland with the closure of that facility.

Recently, work—our union worked with U.S. Wind to bring steel back to Maryland, and Sparrows Point Steel was born. And they are going to be fabricating monopiles for the offshore wind industry at this facility in Baltimore. At the end, 500 jobs will be created. That is a community that has been devastated by the loss of manufacturing jobs. It is a Black and Brown community. It is a community that has been dying for investment.

Those are the types of things that the Build Back Better will help to do, and we are eager to see that happen.

Mr. RUSH. Thank you, Mr. Chairman. I yield back.

Mr. TONKO. Chairman Rush yields back. The Chair now recognizes Representative Upton, Subcommittee on Energy Ranking Member. I recognize him for 5 minutes to ask questions, please.

Mr. UPTON. Well, thank you, Mr. Chairman. It is an important hearing. Energy is on the minds of every—all of our constituents.

And I—Mr. Pugliaresi, I am looking at a story that I know you haven't seen, but it is something you are aware of. The UK power prices soar about—above 2,000 pounds on low winds. Britain is set to end the use of coal within three years, and make power generation free of fossil fuel by 2035. But for now it falls back on high-emission coal when wind drops or demand increases. Wind generation on Monday this week was meeting just six percent of total demand, national grid data shows, while gas contributed 55 percent and coal 2 percent, which is one of the reasons why the cost is so much higher.

And I just know, as we try to put U.S. costs compared to Europe, in Europe they are paying about 5 to $8 a gallon for gasoline, and their electric rates are already 2 to 3 times higher than what we pay in Michigan.

I support renewable fuels, always have, but it is part of the all-of-the-above strategy, and you have got to have something there for when the wind doesn't blow and the sun doesn't shine, which is exactly what happened in England this last week.

So what do we do about that? What do we do about these surging gas prices that are practically double where they were a year ago?

And what signals should we be sending to American consumers across the country to—whether it is encouraging more domestic energy supplies, and trying to get control of some of these gasoline prices?

Mr. PUGLIARESI. Right. First, in terms of the power sector, we have—we are completely technology agnostic. But it is really important to understand that intermittent electricity is not the same product as baseload electricity. It doesn't have the same value because, when you turn the switch, it might not be there.

I actually asked Chairman Chatterjee once, "Why don't we have everybody bid firm power? At least we would have some price discovery." We would find out what—you know, what —because we have these levelized cost estimates, but we really need to understand what it means to integrate these intermittent fuels into our power system.

We have data out of Japan now that suggests they accelerate dramatically once you get past 30 percent of the grid. So some of our technology is just not ready yet. We don't have good backup systems, like batteries. So—and Germany is a classic case. One of the reasons gas demand is spiking in Germany is they shut down their coal facilities, they pulled back on the nuclear plants, and they ended up with a very brittle system, which was not able to deal with uncertainties in the power demand.

Mr. UPTON. So I am going to—want to raise what I will call a Michigan issue, but it is probably more of a Midwestern issue, if you look at it, and that is Line 5, and

I don't know how familiar you are with that. But for those that are watching this hearing, Line 5 is a pipeline that was built under the Straits of Mackinac, connecting the lower and upper peninsulas in the 1950s. It contains not only propane going to the north to help heat the Upper Peninsula, there is electric lines, as well as crude oil that is—goes down to a Marathon refineries in Michigan here, down in the southeast corner of the state.

That refinery, as I understand it, produces about 15 million gallons of fuel a day. Michigan's consumption is about 10 million. There are efforts to eliminate the—or to shut down that pipeline. It needs to be replaced. There is work that has been done, starting with Governor Snyder back a number of years ago with Enbridge, the pipeline company, to try and do that.

There is a—the Biden Administration is considering closing the pipeline, as I understand it, as they look at treaty obligations between Canada and the U.S. What would happen to energy prices if that pipeline gets shut down?

Mr. PUGLIARESI. So, as you know, Michigan, I think, gets about 750,000 gallons a day of propane. It gets, probably—I think I had some data on this, I saw 400—it is 14.7 million gallons a day of gasoline, diesel, and jet fuel.

So this is, actually, a more serious problem than we understand, because the reason we have this valuable strategic asset, this whole North American production platform, is because we solve a whole bunch of very complicated transportation issues every year to allow the platform to be efficient, to grow, and to put us as the largest oil and gas producer in the world.

So it is going to have immediate regional effects, it is going to spike prices. They are going to have to find more truckers to move material. And there are very—as we know, we have a shortage of drivers and truckers.

So I would—we have a PHSMA, you know, the Pipeline Hazardous Material Safety Administration, it is——

Mr. UPTON. I know my time has expired, but in—a one-word answer would be "catastrophic"?

Mr. PUGLIARESI. It would be catastrophic.

Mr. UPTON. Thank you.

Mr. PUGLIARESI. And it would be very harmful to the consumers, very harmful.

Mr. UPTON. Thank you. I yield back.

Mr. TONKO. Mr. Upton yields back. The Chair now recognizes, virtually, Representative Doyle, who happens to serve as chair of the Subcommittee on Communications and Technology.

Mr. Doyle, welcome. You are recognized for 5 minutes, please.

Mr. DOYLE. Well, thank you, Mr. Chairman. As we have seen over the last year-and-a-half, we are too reliant on foreign supply chains for a wide variety of products, even critically-important products like semiconductors. As we continue to recover from the pandemic, we should be investing in bringing home manufacturing for as many supply chains as possible, but especially for critical materials.

In the effort to create a cleaner future and build as strong an economy as possible, I am a firm believer in using all the tools at

our disposal. That means a diverse portfolio of renewables, nuclear, hydrogen, and carbon capture technology.

And if you really want to make America truly energy independent, we should focus on building out the domestic supply chains for technologies that take advantage of fuel sources that aren't reliant on volatile global price fluctuations.

With the limitations of international supply chains on display, and human rights violations in numerous major supplier nations, investing in building a domestic supply chain for clean energy technologies, as Mr. McKinley, Mrs. Dingell, and Mr. Veasey and I did, through including our Battery Material Processing and Component Manufacturing Act in the Infrastructure and Jobs Act is critically important.

This is also an opportunity to invest in new, innovative companies. Companies like Redwood and EOS Energy in my district are creating new, innovative technologies to recycle materials, build components, and pioneer new technologies. Building a strong domestic supply chain for clean energy technologies will create opportunities for American companies to lead the world, create jobs, and make America a truly independent leader in a cleaner future.

Let me first ask Mr. Switzer.

Can you explain how a grant program for battery manufacturing, like we included in the infrastructure bill, could help companies like yours expand your operations?

And how will that help impact the growth of the whole supply chain?

Dr. SWITZER. Sure, thank you, Representative Doyle. And, you know, on behalf of Redwood Materials, we certainly appreciate all of the work that you put in to that provision.

I think, you know, to use a word that someone else used, it is just the scale of it all, the scale and the level of investment that will be needed. You know, for our battery materials facilities that we are planning to construct here, in the U.S., you know, the total scale is going to be on the order of several billion dollars. And that—you know, that alone actually doesn't even completely solve the problem, right? Like, we need several Redwood materials throughout the country to, essentially, kind of build this supply chain for the future.

So I think, you know, all of the provisions in the grants, I think, will be put to good use to help stand up and accelerate our efforts there.

Mr. DOYLE. You know, it is my understanding that we can recycle significant amounts of critical materials from used batteries and from other scrap metals. What is the percentage of the materials that we recover from a used battery?

And how much of the supply chain could come from recycled material, if we had strong recycling programs?

Dr. SWITZER. Sure. I think that is—you know, I think there is a great point to make in there.

And first, you know, to answer your question, of the, you know, recoverable percent of the battery materials, and the end-of-life battery of, you know, nickel, and cobalt, and lithium, we can actually recover and recycle and reuse greater than 90 percent of those elements.

So it is—you know, it is—I think that is a key point, is that it is not like we are extracting these minerals, and then we use them once and they are gone. It is something that we—you know, once they are extracted, and they are in a battery, we can actually use them over and over again. And we can do that here, in the U.S.

So I think that, you know, expanding, continually expanding recycling efforts, as well as collection efforts, to make sure that we collect those end-of-life batteries is absolutely critical.

Mr. DOYLE. Thank you.

Ms. Brown, how can we ensure that, as we domesticate supply chains, that these jobs are good-paying, union jobs, located in areas that have lost manufacturing, or have been historically disadvantaged?

Ms. BROWN. Thank you so much for the question, Congressman Doyle, and thank you. I have to say you have been such a champion and a friend of our union's, and on this issue in particular, going all the way back to Waxman-Markey with the Inslee-Doyle provisions that sought to ensure domestic competitiveness of the domestic industry. So thank you very much.

You know, I would say, for our union and any labor organization, the first thing we would say is to pass the PRO Act. Protecting the Right to Organize Act is the first way that we can make sure that the jobs that are created, our union jobs.

Our experience, unfortunately, has been that a lot of clean energy companies are very resistant to unions. And, you know, our union and others have fought really hard, and have tried for years to organize, and to make those jobs good union jobs.

You know, if you look at jobs in the energy sector, there—or the manufacturing sector, there is a certain standard of living associated with those jobs. On average, our members in the steel or aluminum sector make, you know, $85,000-plus a year, with benefits. It is not——

Mr. DOYLE. Yes, I see my time has expired, and I hope——

Ms. BROWN. I am sorry, go ahead.

Mr. DOYLE [continue]. Take advantage of—I am a stickler when I am the subcommittee chair about time, so I don't want to break one of my own rules.

But thank you for your testimony, and I want to thank all the members for their testimony.

Mr. Chairman, I will yield back.

Mr. TONKO. Thank you.

Chairman Doyle yields back. The Chair now recognizes Representative Rodgers, full committee ranking member, for 5 minutes, please, to ask questions.

Mrs. RODGERS. Thank you, Mr. Chairman. I do think it is important that we take a step back, and really look at what these policy mandates mean, what it is going to mean on American families. I think we just heard the word "catastrophic."

Now, Mr. Chairman, you said at the very beginning, it is difficult sometimes to get our head around this, that these are ambitious energy goals. I would respond to that. The reason it is difficult to get our head around it is because it is divorced from reality. As Mr. McKinley said, we need to focus on reality, we need to focus on the facts.

What the majority is promoting right now under—they say it is a transition to a clean energy future. Yet the reality is it is wind, solar, and electric batteries at the exclusion of everything else. It is not technology neutral. You might want to—you want—you include hydropower, for example, in your list of renewables. Well, in Washington State, Governor Inslee is working hard to tear out the dams in Washington State that produce the clean, renewable, reliable, affordable electricity. It is being threatened right now.

We would welcome a debate around American leadership in reducing carbon emissions, but the frustration is that we are—we seem to be focused solely on mandating wind, solar, and batteries. And telling us to "Trust us, just trust us," that is why it is hard to get our head around it.

One person—well, and is it a clean transition, or are we really focused on reducing carbon emissions? Let's get—let's have the debate around reducing carbon emissions. Let's have that debate, not mandating from Washington, D.C., the Federal Government mandating what qualifies and what not. Let's have really technology neutral.

I met with the Steelworkers last week in Spokane, Steelworkers from Kaiser Aluminum. I am very proud of the work that they do for helping of manufacturing of aircraft in the United States of America, very proud of the work that they have done to help reduce carbon emissions, the carbon intensity of their products, their commitment to clean water.

You know what? They are fearful, though. They are fearful of what is happening. They are fearful of China. They are fearful about losing their jobs. They are fearful of the current approach, that it is divorced from reality.

Mr. Pugliaresi, I wanted to ask you. Well, yes, and there is the California model. Coming from Washington State, we seem to be really wanting to focus on the California example, and I am very concerned. California, they don't have reliability. They don't have confidence that, when they need to heat their homes, they are going to be able to heat their homes. And now they are going to take the generators away that people were buying to try to help keep their homes heated. So they don't have reliability, they don't have affordability, they have the highest gas prices in America.

You, in your testimony, you mentioned the example of Germany. Germany has headed down this path, lots of mandates. And what are they doing now? They are signing a pipeline with Russia to get their gas.

I just—would you speak to affordable energy, the demand for oil and gas globally, and what it is going to mean, when the United States is shutting down American energy, and what does that mean for global energy security reliance, and especially on the people in the world that are living without electricity today that need energy?

Mr. PUGLIARESI. Yes. So the first thing, I think we sort of forgot. Between 2010 and 2019, the United States provided 80 percent of the incremental world demand in petroleum. It was quite a remarkable achievement. And the notion that somehow—you know, and world demand for petroleum is back onto trend. We are somewhere approaching 100 million barrels a day.

Now, at some point, we will use less petroleum. But that is going to take a long time. And if we proceed with a strategy to sort of disarm or to shut down our oil and gas production in the U.S., it is just going to shift the production to somewhere else, and it is going to shift it to the Middle East and Russia. And that is going to impose a very high cost, and a tremendous strategic loss for us. We have spent 40 years——

Mrs. RODGERS. Yes.

Mr. PUGLIARESI [continue]. Becoming energy independent.

Mrs. RODGERS. Right, right.

Mr. PUGLIARESI. We shouldn't give that up——

Mrs. RODGERS. That is right.

Mr. PUGLIARESI [continue]. Until the replacement fuels are ready to go.

Mrs. RODGERS. I completely agree, and it seems to be OK to get our—you know, ask OPEC for more oil, but shut down pipelines in America. This makes no sense.

Mr. PUGLIARESI. It makes no sense.

Mrs. RODGERS. It is divorced from reality. Let's get focused on the real goal of American leadership, reducing carbon emissions, and continuing to lead the world in reducing carbon emissions. Let's—that should be the goal, not wind, solar, and batteries only.

I yield back.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes Representative DeGette, who serves as chair of the Subcommittee on Investigations and Oversight.

Representative DeGette, you are recognized for 5 minutes for questions, please.

Ms. DEGETTE. Thank you so much, Mr. Chairman. And let me just hook on to what Mrs. McMorris Rodgers just asserted. Some of us don't think we should just limit ourselves to wind and solar, so we think that we need to—we do think that we need to have the goal of reducing emissions.

But, you know, there is a lot of hyper-partisanship in this committee and around Congress these days. And I think that is a real shame. Because I think some of these issues that we are talking about today, about supply chain and energy development and minerals, that we can solve these in a bipartisan way that still is environmentally sound.

And so I am going to channel my inner John Dingell for a few minutes, and ask the witnesses if they can please answer the following questions in a yes-or-no way. And I make it easy, because the questions are drafted so you can do that.

The first one is, do you think we should do—be doing more mining of the critical inputs needed for these technologies, here in the U.S., while staying clear of critical water and ecological resources, and respecting the rights of tribal nations and other communities?

Mr. Zindler?

Mr. ZINDLER. Yes, if you want an independent——

Ms. DEGETTE. Thank you.

Mr. ZINDLER [continue]. Energy independence.

Ms. DEGETTE. Ms. Brown?

Ms. BROWN. Yes.

Ms. DEGETTE. Thank you.

Dr. Switzer?

Dr. SWITZER. I think it is a bit complicated. It is —you know, it is hard to say that it is a really, like, a yes-or-no question.

Ms. DEGETTE. OK, so you can't answer it. You don't—so do you think it would be a good goal to mine these things here in the U.S., while respecting the rights of tribes and others?

Dr. SWITZER. I think that, in general, the world will need more mining, but——

Ms. DEGETTE. OK, so what about you? Can you pronounce your name for——

Mr. PUGLIARESI. Pugliaresi.

Ms. DEGETTE. Mr. Pugliaresi, what about you?

Mr. PUGLIARESI. Yes.

Ms. DEGETTE. OK, thank you. Now, should it be a goal of Congress and the Administration within, say, five years, to do most of the manufacturing required to produce our clean energy here, in the U.S., or at least be partners upholding the same high labor and environmental standards?

Mr. Zindler?

Mr. ZINDLER. Yes, it should be the goal.

Ms. DEGETTE. Ms. Brown?

Ms. BROWN. Yes.

Ms. DEGETTE. Dr. Switzer?

Dr. SWITZER. I think our goal should be to transition to clean energy, and then we should continually work in parallel to bring that manufacturing here.

Ms. DEGETTE. I totally agree. Mr. Pugliaresi?

Mr. PUGLIARESI. Yes.

Ms. DEGETTE. Now, should it be a matter of U.S. policy to do the mining necessary for clean energy here, in the U.S. and in countries upholding the same labor and—high labor and environmental standards that we have here?

Mr. Zindler?

Mr. ZINDLER. Yes, assuming we have the resources here.

Ms. DEGETTE. Absolutely.

Ms. Brown?

Ms. BROWN. Yes.

Ms. DEGETTE. Dr. Switzer?

Dr. SWITZER. I would also say yes, with the same caveat around the resources and their economic viability.

Ms. DEGETTE. Mr. Pugliaresi?

Mr. PUGLIARESI. Yes.

Ms. DEGETTE. And should it be a matter of U.S. policy to invest in technologies that reduce the amount of raw materials that need to be extracted in the first place?

Mr. Zindler?

Mr. ZINDLER. Yes.

Ms. DEGETTE. Ms. Brown?

Ms. BROWN. Yes.

Ms. DEGETTE. Dr. Switzer?

Dr. SWITZER. Yes.

Ms. DEGETTE. Mr. Pugliaresi?

Mr. PUGLIARESI. Yes.

Ms. DEGETTE. See, we can find agreement. I really appreciate it, and I know it is—and Dr. Switzer, in fairness to you, I know that it is not always a simple answer.

But in fact, I think we can all agree that our goal should be to mine these materials as much as possible, economically and practically in the U.S., or in places where the same high environmental and labor standards that we have in the U.S. are happening. And that is something that the Democrats agree with. And I know it is something that my Republican colleagues agree with.

So I look forward to working with my friends on the other side of the aisle, Mr. Chairman, to make sure that these things can happen, and I yield back.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes Dr. Burgess, please, for 5 minutes.

Mr. BURGESS. Thank you, Mr. Chairman, and I wonder if I might continue just for a moment in the yes-and-no variety of questions, and we will just go down the list, as Chairwoman DeGette was doing.

Would a real infrastructure bill have included a title on mining, Mr. Zindler?

Mr. ZINDLER. I don't know, I am not a legislator.

Mr. BURGESS. Ms. Brown?

Ms. BROWN. I can't answer that in a yes or no.

Mr. BURGESS. The answer is yes. But Dr. Switzer?

Dr. SWITZER. I am the recycling guy.

Mr. BURGESS. Mr. Pugliaresi?

Mr. PUGLIARESI. Yes.

Mr. BURGESS. All right. Well, thank you for that. And it is important, because we do a lot of big policy things here, in this committee. And we sometimes, I am afraid, lose sight of the implications of that.

And Mr. Pugliaresi, you have provided us with a series of very intriguing figures at the end of your written testimony. And it seems to me, as I look at those, a recurrent theme through that is the timeline from where we are now, roughly 2020, to 2050, which was where we purport to be at a zero-carbon emission energy production. The amount of energy required is going to go up by a lot. It varies, granted, but in your figure 11 on the number of—required, it looks like it could go up a bunch. Was that a fair statement?

Mr. PUGLIARESI. Yes, particularly when you consider the economic growth and the population growth we are going to see throughout the Asia-Pacific and Africa, large regions which are very energy short now, and, as economic growth takes place, energy demand is going to accelerate.

Mr. BURGESS. So, in order to account for that delta, where we are now and what will be required in 2050—that is the year that energy production is zero net carbon—is it possible to accommodate that increase that is going to be required?

Is it possible to accommodate that with the traditional renewable methods, wind, solar, geothermal?

Mr. PUGLIARESI. Absolutely not. You cannot get the density of power these countries need unless we have some major break-

throughs in these technologies. And even if they are possible, if they are costly, I can tell you they will not adopt them.

Mr. BURGESS. So there is a bill that Congress may be voting on before the week is over called the Build Back Better Act. And I had the occasion to spend 16 hours on the floor of the House last Friday dealing with the rule to debate that bill.

And as best as I can determine, there is not one dollar in the Build Back Better Act for research and deployment of new nuclear technology. And it would seem to me, in order to accommodate that delta of energy available and energy that is going to be required, it seems to me that nuclear will have to be part of that complement.

Mr. PUGLIARESI. I couldn't agree more. Nuclear power is the only dense, not—carbon-free fuel alternative that we really have. All the other carbon-free alternatives are—you know, the density of energy they provide is much, much too little to achieve these goals in the developing world.

Mr. BURGESS. Well, I do want to thank you for providing us, I think, some significant facts in your testimony, and certainly the cautionary tale of what has happened in Germany with the too, too quick—the fragility that it has impacted into the system by going too quickly, and abandoning the traditional sources of energy.

Again, I believe that is a cautionary tale for us. And being from Texas, we witnessed what fragility of your energy supply looks like. We only have one week of winter in Texas, but it was a bad one. You may have read about it, it was in all the papers. So fragility in the system is something that I am pretty sensitive to.

We heard on this committee years and years ago, without energy life is cold, brutal, and short. And we kind of saw that up close and personal. So would you worry about imparting that kind of fragility into—and I am just talking about the United States now—into the United States, with too rapid a transition?

Mr. PUGLIARESI. Yes, of course, you know, the power systems are very complex. But integrating renewable intermittent sources in which we don't have a very sophisticated or ample system to back up this power is—we should move with extreme caution.

Mr. BURGESS. You know, one of the probably more frightening things I have heard from a policy perspective—and granted, it came from Senators, which is always concerning, but the desire to abandon the United States being able to export crude oil, to put the ban back on export of crude oil. That is the one policy change in the last ten years that really, I think, has made a difference, as far as making America energy independent. And I really think we should be loathe to give up that independence.

Mr. PUGLIARESI. So while we don't have a lot of time now, the—if we were to begin to shut down U.S.—banned exports, we would actually lose production and have higher prices.

Mr. BURGESS. Thank you, and I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes, virtually, Representative Schakowsky, who serves as chair of the Subcommittee on Consumer Protection and Commerce. And so we recognize Chair Schakowsky now for 5 minutes, please.

Ms. SCHAKOWSKY. Thank you, Mr. Chairman. Now, these are difficult issues to deal with, because all of us, I think, want to make

sure that we have a sufficient energy supply. I think all of us probably want to—definitely want to see more of a supply chain here, in the United States.

But one of the things that has frustrated me the most—and, Ms. Brown, I am going to ask you to respond to this concern of mine—is that there seems to be this thing about making choices between having enough energy, having enough good-paying jobs by using the incumbent fuels and the incumbent manufacturing that we have right now.

And my concern is, you know, we just came off of an international report on how we are really at ground zero for climate change, and the international conference discussing how we are going to protect our planet, you know, into the future for our children and grandchildren.

So I guess the—well, the question that I want to ask, is this a choice between clean energy and good jobs?

And how are we going to make sure that, as we make this transition, that we can guarantee—because we know—and you actually mentioned in your testimony, and explained that many workers are skeptical of the transition to clean energy. And what is it that we can do to make sure that we don't have to choose between the environment and these—and our energy security and good jobs?

Ms. BROWN. Thank you so much for that question, Congresswoman, and a shout-out to the sign that is in the back, there.

No. It is a false choice. And, you know, our former president, Leo Gerard, you know, would say this all the time, that we don't need to choose between good jobs and a good environment. We can achieve both. And that, quite literally, has been the work of our union, going back for more than 40 years, around economic and environmental sustainability. We have always taken the position that it is partially our job to make sure that the employers that our members work for, the companies that they work for, are actually doing their part to be good environmental stewards.

This goes all the way back to the first Clean Air Act up to today, where we stand here, encouraging Congress to move forward with good climate policy, but that you do it by putting workers first, by focusing on domestic industry, by looking at the existing capacity that we have here, in the United States, in each of the sectors that helped to build this economy.

There is a lot of conversation here today about the auto industry and EVs. Domestic industry and domestic workers were such a big part of building that industry in this country. Our members today remain a big part of the auto industry, and bringing that into the future. We represent the largest workers in the auto supply chain.

The entire domestic industry—steel, rubber, cement, glass, aluminum, copper, we—I could, literally, go down the list, in terms of all of the products that Steelworker members make. All of those products can play a role in the U.S. clean energy economy. In ten years the global market around clean energy technologies will be $23 trillion. We should not cede the capacity that we have here, in the United States, to other nations that are racing to get that. We should be building on what we have.

And so, you know, we just—we stand here, you know, we have been here, like I said, for 40-plus years in this fight, and we want to make sure that, as we do this, workers are at the center.

Thank you for the question.

Ms. SCHAKOWSKY. Well, I appreciate that answer. I think this idea that, unless we continue to do things as we have—and certainly, there are many people that—we have to do a really good job about a transition. But if we don't, I think we are in real trouble, and I think that I am grateful that the workers in these industries are part of the solution. So thank you very much for your response.

I yield back.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes Representative Latta, the gentleman from Ohio, for 5 minutes, please.

Mr. LATTA. Well, thank you very much, Mr. Chairman, and thanks to our witnesses for being with us today.

And before we look to the future, I believe it is important that it is—we acknowledge the real challenges that are currently facing our energy producers, and the consequences that will result from the recent political proposals to shut down energy delivery systems in this country. And specifically, I am referring to the operation of Line 5. And as my friend from Michigan has already alluded to, Line 5 is essential to the Midwest.

Earlier this month, after reading press reports from the Biden Administration examining the consequences of shutting down Line 5, I led a letter with 12 of my colleagues to President Biden outlining our grave concerns with this possible action.

Line 5 is essential to heating homes and operating businesses, to our farming operations, and to the continued economic vitality in northern Ohio. Terminating Line 5's operation will exasperate shortages and price increases in home heating fuels like natural gas and propane at a time when Americans are facing inflationary challenges.

Thankfully, it appears the President read our letter, because his White House has walked back their comments, and have said they are no longer considering shutting down Line 5 at this time. We need to continue to make clear that we should be working to improve the lives of hard-working Americans, and not playing political games with their livelihoods or well-being.

Mr. Pugliaresi, you state in your testimony other measures under consideration, such as halting crude oil exports or release of the Strategic Petroleum Reserve without a genuine supply disruption, are likely to be counterproductive. What do you mean by counterproductive, especially when we know that, with the—we have the oil in the ground?

Shouldn't we be tapping into the SPR at this time?

Mr. PUGLIARESI. So the question of the SPR is that it has traditionally—and, in my own experience with it, it should be for a true emergency, for a crisis that threatens national security, or the economic security of the country. And if we tend to use it as a kind of commodity adjuster, I think we are going to diminish its reliability as an important source for emergencies.

Unfortunately, the Congress has also looked at the strategic reserve and, through a series of budget measures that have been

passed over the years to reduce its size—we have generally not thought that was a good idea, but, you know, the Congress will—proceeds with its will on this issue.

So once again, if we are going to reduce its size over time, what we have remaining, we would suggest, be kept in reserve for a true critical emergency.

Mr. LATTA. Well, and again, when you think of the oil that we have in the ground at this time, and being able to reduce Saudi Arabia and Russia—I would say it is not a good time to be using it.

And you also state one of the reasons the U.S. has achieved energy independence is that production at the production platform is efficient. How do you mean efficient?

Mr. PUGLIARESI. So if you think about the United States, it is a very large continental landmass. The notion that you could solve our problems by banning exports is a kind of—not too thoughtful, let's say. For example, a refiner in Hawaii may want to purchase his crude from Indonesia. Well, a—an exporter out of Texas may want to ship his light crude to more efficient processing facility abroad.

But all of that, the fact that we solved this massive transportation solution in the U.S., has ended up in the U.S. being a net exporter. I don't—right now we may be a slight net importer, but—and so we end up exporting some crude oil, but we also end up exporting a lot more highly-valued petroleum products. All of this allows the crude oil to be produced more efficiently, and it also allows us to be one of the largest refiners in the world. And that it—it is that efficient platform which gives us the capacity to expand production over time, and to deal with large variations in crude oil demand.

Mr. LATTA. In my last 45 seconds I would like to switch over to—on the nuclear side, because right now the U.S. is importing over 80 percent of the uranium from other countries.

You know, what are the potential energy and security challenges to the U.S. if we don't invest more in our own domestic mining?

Mr. PUGLIARESI. Well, you know, for uranium, of course, we have a series of not just trade arrangements, but treaty arrangements. I am sure you are well aware of those. But probably, you know, if we can find ways to cost effectively produce more here at home, we should do that. If there are regulatory impediments that are prohibiting that, we would say, OK, we should take a hard look at those, and see what we can do to have a cost effective strategy for producing uranium, as well.

Mr. LATTA. Well, thank you.

Mr. Chairman, my time has expired, and I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes, virtually, the gentlelady from California.

Representative Matsui, you are recognized for 5 minutes, please, to ask questions.

Ms. MATSUI. Thank you very much, Mr. Chairman, and I want to thank the witnesses for being with us today.

We know that we are at the crossroads of an economic and technological transition. Support for clean energy deployment keeps rising, and production costs continue dropping.

But as a person who is very interested in new technologies, I know that increased production demand—increased demand does not always translate into robust domestic production. And that is why I am proud to champion the CHIPS Act, legislation to strengthen the U.S. semiconductor industry, an industry which, as you may know, has experienced a growing influence of foreign companies.

To truly prepare for a clean energy future, I believe it is crucial that we establish industrial leadership here, in the United States, to secure our supply chain and bolster our competitiveness in the 21st century.

Now, as we transition to a clean energy economy, we have the opportunity to do what the fossil fuel industry never did, to set out from the beginning to better protect the communities and environments impacted by energy development. It is my understanding that robust investments in a domestic circular economy for critical minerals is crucial to establish the sustainable supply chain.

Dr. Switzer, can critical mineral recycling help meet the growing demand for these materials?

Dr. SWITZER. Thank you. Yes, it most certainly can, and I think—you know, one important—maybe, like, just an example to highlight on recycling, in particular, and, you know, with regards to cobalt, is there is often a lot of talk of cobalt and cobalt mining.

But the really interesting thing with recycling is that, you know, the batteries that we are putting on the road today in the latest and greatest electric vehicles actually use much less cobalt than the batteries that are coming off the road, or that are coming out of, you know, cell phones and such. So we can actually thrift that cobalt to recycle it, and use it to go farther into—for using—for use in EVs, such that, you know, Redwood Materials actually thinks——

Ms. MATSUI. OK, can I ask you, Dr. Switzer——

Dr. SWITZER. Yes? Yes, go ahead.

Ms. MATSUI. What efforts should Congress prioritize to support the establishment of more critical mineral recycling facilities and better collection infrastructure?

Dr. SWITZER. Yes, I think, you know, with regards to consumer electronics, we certainly—we most certainly need to improve our, you know, collection infrastructure, and that is one of the things that Redwood Materials is working on.

But I also think, you know, further investment in things like recycling technologies, recycling facilities, as well as, you know, the refining and battery materials manufacturing side of the industry is absolutely critical.

Ms. MATSUI. OK, fine. Now, transportation is the most polluting sector in our economy, making electric vehicle adoption critical to improve air quality for our communities and combat climate change.

Mr. Zindler, in your testimony you mentioned that, when it comes to electric vehicles, the most critical and costly component is the battery. Will domestic manufacturing of lithium ion batteries accelerate domestic production and adoption of EVs?

Mr. ZINDLER. So thank you for that question. I would say this, that what we have seen in other parts of the world is that, when

there is a clear signal sent about long-term demand for EVs, fairly quickly an ecosystem of battery production crops up. And that happened in China, which, obviously, had a sort of a history of producing batteries. But China, South Korea, and now Europe very quickly is ramping up. And once there is that signal sent, then very quickly you can see all the various components of battery manufacturing sort of grouped together. But until that signal is sent, you do a lot of importing. And so I think a lot of what the market is waiting for is a clear, clear signal on this.

And I would just point out one thing, which was mentioned earlier, which is to say that the Administration has only supported wind, solar, and batteries. Unfortunately, Congressman Burgess has left, but I, just for the record, would like to point out that there was $10 billion in funding for hydrogen in the infrastructure bill; $6 billion in funding for conventional nuclear reactors, which is critical if we want to achieve decarbonization; $11 billion for carbon capture and storage; and another $3.2 billion for advanced nuclear reactors. So it was a bill that covered a lot of technologies that certainly were not wind or solar or batteries, and it is now law.

Ms. MATSUI. OK. Quickly, one of the emissions comparisons between a newly-manufactured battery and a recycled one—we need to look at everything here.

Mr. ZINDLER. I am sorry, I didn't quite catch that question——

Ms. MATSUI. OK. What are the emissions comparisons between a newly-manufactured battery and a recycled one?

Mr. ZINDLER. What are the nearest comparisons?

Ms. MATSUI. No, emissions.

Mr. ZINDLER. Oh, the emissions comparison. Oh, I couldn't tell you right off the top of my head. Maybe Dr. Switzer can weigh in on that one.

Ms. MATSUI. OK.

Dr. SWITZER. It is a drastic improvement, obviously, because, you know, in a battery, you have got all of those elements in one place that you need, typically at higher concentrations than are in mined ores. It is a dramatic improvement over mining.

Ms. MATSUI. OK. Well, I really wanted to know between a manufactured one and a recycled one, but I will leave that question for someone else to ask.

I yield back, thank you.

Mr. TONKO. You are most welcome. The gentlelady yields back. The Chair now recognizes the gentleman from Virginia.

Representative Griffith, you are recognized for 5 minutes, please.

Mr. GRIFFITH. Thank you, Mr. Chairman. In the National Highway System Designation Act of 1995, the Coalfields Expressway was designated as "a congressional high-priority corridor." Coalfields Expressway, in my part of Virginia, is not built. It is not close to being built. The Coalfields Expressway opens up, as you might guess, the Virginia coal fields, so we can shift our economy. But it is not built. It opens up Dickinson and Buchanan Counties.

We haven't kept our promises from the past. And yet I hear all kinds of laudatory comments today about last week's infrastructure bill. The new money in that bill for highways and bridges coming to all of Virginia is a few billion dollars, at best. Coalfields Expressway will cost 30 billion-plus to complete.

Now, we spent lots of money on new promises, and funding rich folks to buy electric cars, and all kinds of charging station money. And I checked. The cheapest electric car that I could find was 39,999. A battery to replace a battery in a car that starts to degrade around 65,000 miles, and is generally guaranteed up to 100,000, but only—but that doesn't mean it is at 100 percent, but to 100,000 miles—a new battery costs between 5,000 and 15,000. Dickinson County, Coalfields Expressway. According to an article in today's online news, the Cardinal News, household income under 30,000.

Mass transit in rural counties is not an option. The folks I represent can't afford an electric car. It doesn't matter how wonderful it is. And when used ones come along, they are not going to be able to afford those either, because just a new battery will cost them 5,000 to $15,000.

I know there are a lot of good intentions. And sometimes I think we live in two different worlds. Because Virginia has—in Northern Virginia—has five of the wealthiest counties in the country. But the part I represent, the whole area I represent, 29 different jurisdictions, including Blacksburg, Virginia and Montgomery County, which has some wealth, and the Roanoke area that has some wealth, the house—median household income is about 48,000, a little over 48,000.

So, Dr. Switzer, I am all for your recycling. Can you bring a plant to my area? Can you bring jobs to my area?

Dr. SWITZER. I think there is a tremendous opportunity for, one, domesticating the supply chain for—so for bringing plants to the United States. I think those plants do come with thousands of jobs.

Another point on the cost is, you know, the cost of——

Mr. GRIFFITH. Will they come—but will they come to an area that doesn't have a good highway system, and takes you about an hour to get to an interstate?

You don't have to answer that question. It was a rhetorical question. Let me get on to what I originally was going to talk about before I got fired up about folks thinking all of this was going to solve all the problems of the world.

Would it make sense for you all to build in an existing plant, to expand an existing plant, or to retool an existing plant that is already there? Would that make some sense for you?

Dr. SWITZER. Yes, we are evaluating all options, including, you know, what we would call brownfield or existing plants.

Mr. GRIFFITH. I appreciate that. And what type of air emissions and waste will your facilities produce, do you all know?

Dr. SWITZER. So we are targeting net zero. I mean, you know, our mission is really around driving the reduction of emissions, so we think we need to lead that space, and are really targeting zero emissions, with as little to no waste, re-purposing any waste, essentially, as byproducts that can be sold into the market.

Mr. GRIFFITH. Mr. Pugliaresi, anything you want to add to what I have had to say, and the questions I have asked Dr. Switzer?

Mr. PUGLIARESI. Yes. So I do think that one dilemma we face is that, well, we have this aspirational goal. We need to move to technologies that are actually more cost effective, cheaper than what we are using now. Because, for large parts of our national economy,

if transition to the fuels of the future mean their bills go way up, I think they are going to—we are going to be very unhappy, because they are going to resist these things.

Mr. GRIFFITH. And when those fuel costs go up, it is going to cost the people in my district a lot of money. And it is not just a few pennies here and there, as some might feel, but it is real pain.

I have to yield back. I appreciate all of you. Thank you.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentlelady from Florida, who serves as chair of the Select Committee on Climate, and I recognize the representative for 5 minutes, please.

Ms. CASTOR. Well, thank you, Chair Tonko and Chair Rush. Thank you to our witnesses. This is a very important topic, because developing a low-carbon supply chain here, in America, is how we are going to create new jobs, and reduce costs on consumers, and boost our economy. It also has the side benefits of improving public health and reducing harmful carbon pollution.

The—I think the clean energy economy is the surest way to reduce household energy costs over the long term, and ensure reliable energy in the face of volatile fossil fuel markets. So let's talk a little bit about that.

And it really is exciting for you all to be here and talking about this the day after we signed this historic Infrastructure Investment and Jobs Act. It was great to see the bipartisan attendance there on the South Lawn yesterday. And back home in Florida, folks are so excited to get to work now on clean energy and resilience, and making sure that our kids have a more livable planet.

But everyone across the globe is dealing with the volatility in the fossil fuel markets, and uncertainty from the ongoing pandemic, and that includes businesses and factories making the products that we buy, especially when it comes to all of the components that go into clean energy. These volatile fossil fuel prices are yet another reason we should be moving as quickly as possible to cheaper, cleaner energy.

So Mr. Switzer, given the impact of high fossil fuel prices across the globe, wouldn't it—wouldn't benefit—wouldn't businesses benefit by decoupling supply chains from increasingly volatile fossil fuel markets?

Dr. SWITZER. Yes, I think so. I think not only decoupling them, but also localizing them to the United States.

Ms. CASTOR. Go into that in greater detail. I mean, this is a big country. We have different resources all across the country. The Biden Administration is focused on implementing those kind of strategies. What advice would you give them across this big, beautiful, diverse country?

Dr. SWITZER. I think, you know, one of the things that has brought this to light so recently is the semiconductor situation, and, you know, kind of the havoc that it has wreaked throughout the supply chain. And I think a lot of our partners and—are starting to really evaluate kind of how their supply chains are set up, and what the risk is across the supply chain.

So we think that there is, you know, a certain degree of supply chain security that can be had by localizing manufacturing here, to the U.S. But we also think, you know, coupled with that, there is,

of course, jobs. And then, coupled with that, there is the idea that we can reduce the cost by doing so. So it seems like it would be a win-win, to us.

Ms. CASTOR. Mr. Zindler, would you like to add your views?

Mr. ZINDLER. Just—was a couple of quick thoughts, which is just to point out the basic thing, which is that, you know, renewable energy, effectively, has zero marginal cost. So, you know, unless you know differently, you don't have to pay for wind, and you don't have to pay for sun. So typically, in competitive electricity markets, it is wind and solar that are reducing the cost of electricity, not raising it.

When we think about some of the factors that have affected the spikes in prices around the world, typically we are talking about higher fossil fuel prices that have been contributing to that, and some—frankly, some political actions from Vladimir Putin and others that have had some real effects on that, as well.

So I think it is just worth pointing that—making that one basic point, because we have heard a lot about higher energy costs, and there is no question that they are higher. But actually, the electricity prices have not been going up as much as gasoline prices. And part of that is because of renewables.

And the last thing I would point out is also, is we think about the 800 million people who lack any electricity access in the world right now. The lowest cost potential solution for that is solar plus a battery. It is cheaper than a diesel generator, and it is particularly cheaper now that diesel costs are higher. And so the opportunities for export and for global proliferation of these technologies remains, thanks to the current conditions.

Ms. CASTOR. And we want America to be in the lead. We want to build these industries, and improve our supply chains to help the world in the transition to clean energy.

I am hopeful—I am out of time, but I am hopeful that the Steelworkers can be an integral part of that, as well. So thank you very much for appearing here today.

I yield back my time.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes the gentleman from Ohio, Representative Johnson.

You are recognized for 5 minutes, please.

Mr. JOHNSON. Thank you, Mr. Chairman. You know, I might point out that the cause of the uncertainty right now in energy costs in America has more to do with the policies of this Administration that is making it difficult for investors to invest and producers to produce. And the only thing volatile about fossil fuels is how efficiently and low cost they burn to heat and fuel America's homes.

But, you know, as we sit here today, America is going through an unprecedented energy and inflation crisis. And unfortunately, the Energy and Commerce Committee, the committee that has the authority and the power to do something about it, is not rising to the occasion.

Just a couple of weeks ago, as reports predicting winter's price spikes for gasoline, propane, and heating oil made headlines, what did this committee do? It hosted a hearing on offshore wind mills. You heard that right, windmills. Now we are back here again,

using our limited time and resources discussing batteries, solar panels, and renewable power projects, all of which dangerously rely on China for the processing and manufacturing of critical components.

Friends, winter is here. If the United States Congress is going to do something about this current energy crisis, it is our job, as the Energy and Commerce Committee, to hold hearings on it. Republicans have asked for hearings, Mr. Chairman, but that call has gone unanswered by the majority. The hardworking families we represent need to heat their homes, not be lectured to by Democrats fresh off their Scotland trip, hobnobbing with the international elite on how we must rush to a decarbonized, green future.

So speaking of Europe, Mr. Pugliaresi, in your testimony you mentioned Europe as a cautionary tale that we, as policymakers here, should learn from. For example, it has been widely reported that Germany is the country who has gone down the rush to green path the furthest, resulting in German citizens paying some of the highest prices for energy in the entire world. Recently, White House Press Secretary Jen Psaki, in response to concerns about energy price spikes here at home, said that we need to "double down on our investment and our focus on clean energy options."

Mr. Pugliaresi, drawing on your expertise, studying European energy policies, will my constituents and constituents around this country pay more or less for electricity, gasoline, and propane if Democrats double down on weather-dependent renewables, while continuing this war on oil and gas production here at home?

Mr. PUGLIARESI. So thank you so much for that question. Actually, just yesterday, Tudor Pickering issued a very interesting report, and they showed that the price of electricity was highly correlated to the penetration of renewable fuels. Because even though, admittedly, wind and solar can be quite cheap, integrating them into the power system is not. And as the percentage rises in those systems, as they have in Germany, and as they have in the UK, intermittent sources are cheap when they are working. When they are not working, they can provide system instability and rising costs, because the fuels are so expensive to back them up.

Mr. JOHNSON. So the basic answer to your question is, if they double down on this——

Mr. PUGLIARESI. You are going to have——

Mr. JOHNSON [continue]. We can expect our constituents to have higher prices.

Mr. PUGLIARESI. Absolutely.

Mr. JOHNSON. Well, Mr. Pugliaresi, in 2019 the U.S. became a net energy exporter, and achieved the most energy secure position we could possibly be in. Energy prices were affordable, and consumers benefited across the entire country. Under the Biden Administration, gas prices have nearly doubled since last year. Inflation is surging across the board, a major factor being the energy cost to get products to market. And yet Democrats want to keep America's abundant and affordable oil and gas resources in the ground, raising taxes, and increasing regulations.

What effect will this flawed Biden strategy have on energy prices this winter, and looking ahead to next year?

Mr. PUGLIARESI. So, you know, I am reluctant to blame the short-term thing on all the measures that the Administration has undertaken, but—because I think they are largely related to the COVID pandemic.

But they are setting a set of expectations. And expectations—even though expectations do show up in current behavior, in storage ideas, how much money people are—you know, how we are going to deal with supplies. And so I think the mistake the Administration is making is they are creating an expectation of pessimism regarding the U.S. capacity to produce more oil and gas, the restrictions on Federal lands, the hostility towards oil and gas, when it is the fundamental fuel the world is continuing to use.

So I think they are sending the wrong signals, and those are showing up in the marketplace, but it is hard to measure them.

Mr. JOHNSON. Thank you.

Thanks for the indulgence, Mr. Chairman. I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes, virtually, the gentleman from Maryland.

Representative Sarbanes, you are recognized, please, for 5 minutes.

Mr. SARBANES. Thank you very much, Mr. Chairman. I appreciate the opportunity. And I want to thank the witnesses who have joined us today.

I am very pleased to see this recognition that, in addition to being a very critical step, obviously, in improving the health of our environment, this ongoing transition to a clean energy and renewable future, and the manufacturing that can go with it, has the potential to be a real leading edge in economic growth for the country.

Creating, deploying clean energy technologies offers a really valuable opportunity for this to foster growth in American manufacturing industries, which can help them thrive, obviously, and to create jobs and rebuild the economy. This is particularly true for communities like Baltimore, that I represent, that were historically manufacturing hubs, and still retain significant manufacturing resources.

Ms. Brown, could you speak to some of the specific ways that developing renewable energy projects can provide jobs and revitalize communities that used to be more active in manufacturing?

In other words, thinking about how we reclaim some of these manufacturing hubs with the clean energy jobs opportunities that we are speaking about.

Ms. BROWN. Thank you for the question, Congressman. And earlier I mentioned Sparrows Point Steel, which is the new steel fabrication facility that is on the hallowed grounds of the former Bethlehem Steel in Baltimore. And, you know, I think how that project came together is actually a model for what can be done, as we look at communities around the country that really do need to be revitalized. That was a true partnership between our union and U.S. Wind.

You know, I think there was a respect there, on the part of U.S. Wind, for what that facility meant to our union, how important it was to our DNA. But also, they saw the, you know, the Baltimore area as one that really did need an infusion of economic activity.

And so we came together to work towards that project really being developed, and we continue to work together. We are going to work with them to attract the workers for this facility so on the other side of it, again, you know, we will have about 500 folks working at that facility, and they will all be members of the Steelworkers Union. So that is a model that we support.

Mr. SARBANES. That is terrific. Let me talk a little bit about this idea that, while we want to explore the opportunities to restore manufacturing as we make these green components of a clean energy future, that we want the manufacturing process itself to also be green.

And maybe, Ms. Brown, you could speak to this, and also Mr. Zindler. How do we ensure that the types of manufacturing that we are talking about today are themselves low emissions, so we are getting that green current, in a sense, to all aspects of the operation?

Ms. BROWN. I will speak quickly, so that we can get to Mr. Zindler, but the Department of Energy plays a huge role here. We have a huge feat to decarbonize the industrial sector, broadly. And they are rich in resources and innovation to help the industrial sector get there. And so we have worked with them really closely over the years. We continue to work with them now to identify the technologies like direct capture, carbon capture, and others that, hopefully, policies will pull forward to help decarbonize the industrial sector.

Mr. SARBANES. Thank you.

Mr. Zindler?

Mr. ZINDLER. If I understood, the question was around making sure lower emissions around the manufacturing of clean energy goods.

Mr. SARBANES. Correct.

Mr. ZINDLER. Hard to answer that in 40 seconds. And I know Dr. Switzer probably better. But I would just say that, in particular, up the value chain, batteries, as we think about it, and mining is probably an area for real focus, both from—at the very beginning of life, and the very end of life, in terms of recycling. And some of the policies that, frankly, are not—which have not been adopted yet, I think are worth closer consideration to incentivize that type of activity.

Mr. SARBANES. Great, thanks very much.

I yield back, Mr. Chair.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from Indiana.

Dr. Bucshon, you are recognized for 5 minutes, please.

Mr. BUCSHON. Thank you, Mr. Chairman.

Mr. Zindler, are you an economist?

Mr. ZINDLER. Am I a what?

Mr. BUCSHON. An economist.

Mr. ZINDLER. I have been an energy industry analyst for 15 years.

Mr. BUCSHON. OK, an economist, not a trained——

Mr. ZINDLER. I have——

Mr. BUCSHON. You are an analyst. You are a journalist.

Mr. ZINDLER. I have an MBA. I don't know what you——

Mr. BUCSHON. OK, so you are a——

Mr. ZINDLER. I don't have a Ph.D.

Mr. BUCSHON. The reason I am asking is because you are talking about a lot of economy stuff, and you are a journalist that covers the—and commentator that covers——

Mr. ZINDLER. My firm——

Mr. BUCSHON [continue]. The clean energy industry, correct?

Mr. ZINDLER. Could I answer the question?

Mr. BUCSHON. Yes.

Mr. ZINDLER. My firm has been providing research to major investors in clean energy——

Mr. BUCSHON. OK.

Mr. ZINDLER [continue]. And all energy, including, I would add, oil majors and others for 15 years.

Mr. BUCSHON. OK, I just wanted to clarify that, since you seem to be talking about the economy.

The other thing I want to say is all of us up here on the dais represent different areas of the United States of America. We don't represent Germany, France, England, or anywhere. So I know there has been a lot of comments—I am not directing this to you, I am just saying in general—about what other countries are doing. I don't really care. I care about what the people in southwest Indiana are doing. That is who I represent, just as Morgan Griffith talked about Virginia. So I just want to clarify that.

When I saw the hearing I thought we were going to be talking about supply chain things that would help my constituents, who are spending more of their money than ever for Thanksgiving meals, Christmas presents, et cetera. Unfortunately, again, we are focusing on creating supply chains for wind and solar energy.

Don't get me wrong, I support that. I believe it is important for private industry to continue innovating to reliable—reliably, affordably, and sustainably to meet our energy needs. And I am supportive of an all-of-the-above technology, innovative process. However, at this time, my constituents in Indiana are experiencing rising inflation, paying gas prices at the pump that are nearly 70 percent higher than last year, and seeing their energy bills increase just in time for them to need to heat their homes in the winter. That is what I am concerned about. This committee's attention needs to be focused on those things.

And as it relates to the current energy crisis, COVID has had a major effect, no doubt. But I am concerned that the Administration's unfriendly policies toward domestic energy producers and the—I mean, dramatically unrealistic goals—I mean, I get it, but the elephant standing over in the corner of the room is everybody in this room knows that these goals are unrealistic and can't be accomplished. We all know that, right? It is a political thing. It is trying to help certain industries, because it is political. We all know this is unrealistic timelines, I mean, we should just quit fooling ourselves.

And also we are surrendering our energy future to foreign countries, and hurting ratepayers at home, when the foreign countries don't even like us.

And as we look for the supply chain of wind and solar, I would be remiss if I didn't join my colleague in pointing out that a more

certain, reliable supply chain, if we opened our lands to mining critical minerals and rare Earth elements in environmentally safe—in an environmentally safe way, rather than being dependent on child and slave labor—that is what it is, that is the other elephant in the room—we all know what is happening in China and other areas of the world. We look the other way, because it is benefiting our green energy goals here, in the United States.

And I do find it interesting the same people promoting this massive expansion in demand for batteries, and a massive expansion that has been talked about, are the same people supporting the environmentalists who are shutting down our ability to mine fossil fuels in this country. And if you don't think their next step is going to be not allowing domestic production of the minerals we need to expand our clean energy goals as it relates to battery technology, you are fooling yourself. It is just craziness.

So Mr. Pugliaresi, again—and I know we have gone over a lot of this—I am further down here—but could you describe again the extent in which our country is reliant upon foreign countries like China to supply the key components needed to build solar panels and wind turbines?

Mr. PUGLIARESI. So yes. So if you look at some of the critical components there in the charts, it is quite interesting that the demand for these components accelerates dramatically as we rely more on renewable technologies. And that is not an area where we have an advantage right now. And the area we do have an advantage is oil and gas. We are the world's largest oil producer, the world's largest gas producer. We are a dominant player. We can affect what happens to prices if we ensure that the industry remains efficient and can produce at capacity.

Mr. BUCSHON. So let me say I have—I am intrigued by the recycling situation—and this isn't a question for you, but just—in my own office, years ago, I started—OK, what are we going to do with all these solar panels, you know, when their end of life—25 years, or whatever. You know they all go to landfills right now, right? They have, like, all kinds of bad metals in them, including lead and others. We just throw them—in the United States, we throw them in a landfill. I think everybody knows that.

So I started looking into, well, what are we going to do about that? What does Europe do? Well, they recycle. And, you know, they are trying to do that. And so I approached the industry that produces them, potentially, in the United States, and they were adamantly against recycling. Adamantly against it. And you know why? They said, "Because we can't compete with China already. How are we going to compete if you force us to put recycling in the life—in the entire life of our solar panels, here in the U.S.?"

So we are looking the other way when it comes to recycling. Everybody should look at just throwing all these things in landfills, because that is what we are going to do. You know, if we want—we are truly interested in this, let's quit being hypocrites, and look at the entire life chain, or whatever you want to call it, of renewable projects.

I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from California. Mr. McNerney is recognized for 5 minutes, please.

Mr. MCNERNEY. Well, I thank the Chair, and I thank the witnesses for your testimony this morning.

I also ask that the gentleman from Indiana please refrain from speaking for me on the committee here in these hearings.

Today we are already in the era of disruptive climate change. Decades of inaction have now required us to rapidly decarbonize our economy, or else subject future years to disaster after disaster.

And, you know, any Energy and Commerce hearing would not be complete without one of the Republicans off-based California bashing. Today I will thank the ranking member of the full committee for that honor. But as we saw in February's winter storm in Texas, having a domestic supply chain of fossil fuel is not sufficient for energy resilience. Instead, it demonstrated a need to rebuild our energy system based on resilience.

And I agree again with my Republican colleagues that we need to invest in nuclear energy, including advanced nuclear energy, and that is why I voted for the bipartisan infrastructure bill, which includes support for nuclear energy innovation, funding to keep existing nuclear plants online, and $6 billion for micro-reactors, small modular reactors, and advanced nuclear reactors.

It is also why I support the Build Back Better Act, which includes a nuclear energy tax credit and $500 million for high-assay, low-enriched uranium, both of which are important investments in our nuclear generation capability.

If my Republican colleagues want to walk the walk on nuclear energy, they should have voted for the bipartisan infrastructure bill, and they should vote for the Build Back Better bill.

So I am very excited this morning to hear from Dr. Switzer about how much our battery supply needs can be met by recycling of battery—existing batteries.

Dr. Switzer, are there other battery chemistry and storage technologies available that are less reliant on critical minerals, or use more readily available material inputs?

Dr. SWITZER. Thank you for the question. I would like to answer your question, but just, you know, one kind of point of clarification from a previous comment around the recycling of solar panels is actually that Redwood Materials, you know, only just recently announced that we are actually recycling solar panels, in partnership with a company called ERI out of California. So I do think that recycling of solar panels can be done, and we can recover those minerals out of solar panels economically.

Mr. MCNERNEY. Good.

Dr. SWITZER. With regards to battery chemistries and reducing the reliance on any given mineral, I think that is happening. There are a number of different battery chemistries under development. Some are being commercialized today, and the chemistries are constantly changing with respect to the elements they contain.

And again, to a specific example, there would be cobalt and the continuing reduction of cobalt in battery chemistries.

Mr. MCNERNEY. What kind of Federal support is needed, then, to diversify material inputs for grid scale batteries?

Dr. SWITZER. I think continued investment and support of not only kind of research, but also the manufacturing that needs to happen here in the U.S. is critical. I think we can't only focus on the front end of research. We have also got to focus on the commercialization and manufacturing.

Mr. MCNERNEY. Thank you. I am very pleased to see that the U.S. has built on my early work in wind energy technology development by creating a robust wind energy manufacturing industry operating across more than 500 facilities. The industry has now reached a point of maturity, where the early wind turbines have reached the end of their operational lives.

Mr. Zindler, are there investments being made in identifying new recycling processes or bases to recycle wind turbine blades?

Mr. ZINDLER. There are, although, to be honest with you, I can't recall exactly where at this point. Happy to follow up with you afterwards.

Mr. MCNERNEY. OK, thank you.

Ms. Brown, in your testimony you discussed mistakes the U.S. solar energy made in—that resulted in offshoring of much of the manufacturing. Are there lessons to be learned from the onshore wind industry, which has a relatively robust domestic manufacturing presence?

And how could these be applied to more nascent clean energy industries?

Ms. BROWN. Actually, thank you for the question, Congressman, and it actually goes back to the remarks I made earlier about the work that was done with the onshore wind industry and our union. We, many years ago, worked with the American—then-American Wind Energy Association to increase the domestic content used in onshore wind, because at one point it was abysmal.

And, you know, ultimately, after that work that we did together, the percentages were upwards of 50 percent. But it came with a partnership, and a willingness on their part to make different investments. So I think that is a model, again, that we can follow, is look at other technologies.

Mr. MCNERNEY. Thank you.

Mr. Chairman, I will yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from South Carolina.

Representative Duncan, you are recognized for 5 minutes, please.

Mr. DUNCAN. Thank you, Mr. Chairman. I want to thank Mr. McNerney for his mentioning of nuclear power, and I agree with him. I think we ought to take it up in a separate bill dealing with the next generation of nuclear power, and not in a socialist $3.5 trillion spending bill.

But we have heard a lot about the infrastructure bill just signed into law by President Biden yesterday. But I believe that the Tax Cut and Jobs Act created more jobs because it did it through private dollars and tax savings, incentivized innovation and development in the private sector, versus spending American tax dollars, $1.2 trillion in American tax dollars, to try to create jobs with government money.

Let's follow the science and the facts. Let's not use manipulated computer models, or hockey sticks, or unrealistic timelines. The

United States of America, without being mandated to comply with wealth redistribution treaties and accords coming out of Kyoto or Paris, has actually lowered its carbon emissions below the targets that were set by those accords. And they didn't do it because they were mandated; they did it because American innovation and technology—why and how? Innovation, period.

The problem with these accords and treaties, including the recent climate summit in Glasgow, is less about what was in those treaties and accords and more about who wasn't there, and who wasn't party to that, and that is China and Russia, period.

Mr. Chairman, if we are really serious about global climate, instead of further hurting the American economy, American families paying much higher prices at the pump and in their utility bills, and attempting to kill the robust and thriving American energy industry—well, it was thriving before Joe Biden became President Joe Biden—we should hold a hearing on the true polluters, China and Russia, and massive emitters of carbon that were not present and part of these accords.

If the world wants to really address global carbon emissions that many believe are contributing to climate change, how do we do that when China can continue to pump carbon at higher and higher levels through, what, 2030, 2035? And Democrats want to penalize American industries and require average American families to pay more to heat and cool their homes, to drive their kids to school, or drive their car to attend their worship service at their church.

America needs and Americans demand a 24/7, 365 baseload power supply.

Now, Ms. Brown represents the United Steelworkers, and in order to make steel, and refine aluminum, and manufacture titanium products, these industries require huge amounts of power generation, huge. The smelters run on a heck of a lot of power, and it has to be always on, and always available, because you don't want that puppy to cool.

Mr. Chairman, we need a hearing on nuclear power, and how it will play a part in the energy security and in our energy future, especially when you think in terms of that 24/7, 365 reliability.

And Ms. Brown, this is rhetorical: Have the Steelworkers thought in terms of 24/7, 365 baseload power powering furnaces to smelt iron into steel?

You see, you say in your testimony that a transition to a clean energy economy can and will, with government support, will ensure the preeminence of American manufacturing sector for the rest of the 21st century. You went through a list of United Steelworkers—and you represent steel, glass, rubber, paper, concrete. But the manufacturing of all these requires tremendous energy usage. I understand that your members want to manufacture the clean energy components, and I want to manufacture them here, as well, because I believe they are part of the future. And I would much rather manufacture them here than have China or somewhere else manufacture them.

But right now China does, as well as they mine most of the rare Earth minerals that make it all possible, because they control the mineral rights and do the mining. China can do all this much

cheaper than here, in the United States, because they don't have to pay union wages, and they operate state-owned entities.

We did a hearing on legislation to address the future of nuclear power, the next generation, because, guess what? That is another area that China is beating us, is in the future of nuclear technology.

Let me end with this, and my time. Socialism controls and pushes its version of the future onto a populace. Free markets create the renovation and investments. Let's unleash the American ingenuity and innovation, and create our own energy future.

I believe, as many Republicans do, that wind and solar and hydrogen, and all these emerging technologies, ought to be part of the energy matrix. We truly believe that. And we believe—because we have seen it—that the American economy, the innovators and entrepreneurs, will create these products. They will, if there is a market for it, and if they truly believe in it. It shouldn't be a socialist government pushing that down.

We can do that, while we continue doing what we have done over the last 20 years, and that is lower America's carbon emissions without being held hostage to these accords that punish the United States, and punish the United States manufacturers, punish our energy sector, punish moms and dads by paying higher prices at the pump, higher prices for their utilities to heat and cool their homes, and we allow our adversaries to continue unfettered. And that is not fair to America.

And with that, I yield back.

Mr. TONKO. The gentleman yields back. We now recognize, virtually, the gentlelady from New York, former vice chair of the full committee, standing Committee on Energy and Commerce.

Representative Clarke, you are recognized for 5 minutes.

Ms. CLARKE. Thank you very much, Mr. Chairman. And I thank our ranking members for holding today's hearing on the importance of strengthening our domestic supply chains and investing in clean energy—in a clean energy economy.

And to our witnesses, who have graciously joined us today, allow me to thank you for your testimony.

As a nation, we will not address the existential threat of climate change with a singular solution. Rather, we will need to utilize all the tools in our arsenal, especially bold investments and advancements in renewable energy. I believe it is important we continue to build out this industry, and I am happy to see the Biden Administration's plan to expand the country's wind energy output to 110 gigawatts by 2050.

I strongly believe that we—me and my constituents in Brooklyn—have a prime opportunity to ensure that the Administration achieves this crucial goal, while tackling the climate crisis. So in Brooklyn we have the opportunity to—an ability to lead the nation when it comes to offshore wind production. Already, plans are in place to build a new wind turbine assembly plant in the South Brooklyn Marine Terminal to expand offshore wind farms in Long Island, which will generate a total of 3.3 gigawatts of energy per year, enough to power more than 1.8 million homes.

We talk all the time about bringing forth a Green New Deal, and how important it is that we create new green jobs and the clean

energy economy. Well, now is the time. And bold investments in offshore wind is a big part of how we do it.

So, Ms. Brown, the Federal Government has several tools, including the Department of Energy's Loan Programs Office, the Department of the Interior's offshore leasing process that support the financing or permitting of offshore wind projects. Do you think the Federal Government can or should use those programs to ensure that federally-supported projects are making investments and building a domestic offshore wind supply chain?

Ms. BROWN. Thank you for the question, Congresswoman, and absolutely.

But I also think there needs to be some additional work done. There is not enough done to actually connect the dots between what is domestically available, when it comes to offshore wind, and that work needs to be done.

There was a video, actually, that our president sent around to a few of us the other day that really lays out the tremendous array of components that go into an offshore turbine. And we really need to do a full-scale scope-out of what is domestically available, so that we can then connect those domestic producers to those projects. That is the work that our union is focused on right now, to make sure that we are identifying the supply chain, and that we are connecting that supply chain, whether they are in Ohio, or Virginia, or South Carolina, or Georgia, or wherever they are in this country, to the projects that are being created in Long Island, and Maryland, and other places around the country.

Ms. CLARKE. Thank you, Ms. Brown.

Mr. Zindler, in your testimony you detail some of the complexities associated with wind turbine production. Can you elaborate on the current state of our domestic manufacturing capabilities, as well as their potential?

Mr. ZINDLER. So, for onshore wind turbines, at the moment, there is only six countries in the world that can produce every component of a wind turbine, and the U.S. is one of them.

And so, for the final wind turbines that have been built onshore—and I am focusing on onshore, because we basically built almost nothing offshore—the U.S. primarily meets its own demand with our own supply for the final turbine. However, there is a considerable portion, typically, of these turbines—maybe 30, 40 percent—that consist of components that are often imported, including from places like China.

So, you know, it is a more localized supply chain. Certainly, in the solar industry, it has been. But it is not fully, 100 percent U.S.-made, typically, for a typical wind turbine that gets installed.

Ms. CLARKE. Thank you.

Ms. Brown, given a well-trained workforce is critical to the development of a competitive supply chain, what measures is the USW taking to ensure that its members are prepared for the clean-energy jobs of today and tomorrow?

And is there a role for the Federal Government to further support those workforce development efforts?

Ms. BROWN. Thank you again for the question. I will reverse my response.

Yes, there is a huge role for the Federal Government to support workforce training programs, absolutely. We have to make sure that, as we are looking at where to make the investments in specific communities—we have talked a lot about Baltimore—there are other communities around the country, rural areas. As we are making investments in these communities to bring manufacturing or whatever, that we are then also lining that up with workforce training in those communities.

In terms of our union, you know, we are not a building trades union, so we don't run a hiring hall, but we do work really closely with our employers to make sure that there is consistent on-the-job training, as these technologies are being advanced and created.

Ms. CLARKE. Thank you.

Mr. Chairman, I yield back, and I appreciate your indulgence.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes the gentleman from Michigan.

Representative Walberg, you are recognized for 5 minutes, please.

Mr. WALBERG. Thank you, Mr. Chairman, and thanks to the panel for being here today.

Mr. Chairman, with all due respect, we may sound like a broken record here, but that is only because the majority continues to ignore the reality that there is an energy crisis raging across our country and in my state of Michigan right now. Gas prices are soaring by 80 percent, heating bills are projected to be nearly 60 percent more expensive this winter, and supplies are waning, and that is a big deal for Michigan in the winter.

Our President admitted that he has no solutions, and our Energy Secretary, our former governor in Michigan, laughed. She laughed at American families struggling to afford to heat their home or drive their cars.

This hearing is supposed to be about the supply chain challenges of a zero-carbon economy. How about instead we first focus on the supply chain crisis of the current energy economy?

Mr. Pugliaresi, I am sure you have read the recent reports that the Biden Administration is considering shutting down Line 5, as Michigan Governor Whitmer is attempting to do in court. Some reports are saying the decision may solely be based on political pressures. That is a scary thought.

You have decades of experience in dealing with energy security issues at the highest level of government. In your opinion, what would be the impact of a Line 5 shutdown, as it relates to our national energy strategy?

Mr. PUGLIARESI. So, in my view, that is two—first, it is a horrible idea. Let's just get that out there, it is a horrible idea.

Mr. WALBERG. And unnecessary.

Mr. PUGLIARESI. It is very unnecessary. And also, it is—I don't believe—of course, I don't want to speak on legal matters, but the pipeline and Hazardous Materials and Safety Administration is responsible for this.

This is a regulatory matter to be handled under treaty between the United States and Canada, and it is in this manner for a good reason. We view the construction of pipelines as part of the sort of

foundation, you know, infrastructure within the U.S., and it should not be affected by short-term political whims.

I really think, you know, we went through this period of low oil prices and low gasoline prices, and, in a sense, we have—we sort of forgot how valuable all the investments in infrastructure and the revolution we had in technologies that made us such a large oil and gas producer.

Mr. WALBERG. And it had a positive impact, didn't it? And——

Mr. PUGLIARESI. It had an enormous impact. It is one of the main reasons our emissions of carbon are declining, so—have declined so rapidly over the last ten years.

Mr. WALBERG. Far cleaner petroleum resources coming from our suppliers, both Canada and the United States, as opposed to Russia, isn't it?

Mr. PUGLIARESI. Absolutely.

Mr. WALBERG. In your testimony you state that the public support for clean energy transition will hinge on the availability of reliable and affordable energy, which remains the lifeblood of our economy and our national security, and that cutting off production of legacy fuels will backfire horribly and erode public support for a clean energy transmission.

In your opinion, will shutting down existing safe and reliable oil and gas pipelines increase or decrease public support for a clean energy transition? Why or why not?

Mr. PUGLIARESI. They will dramatically decrease it, because the public is not prepared and unwilling to pay the very high prices of a transition program which is—accelerates so quickly that it raises the cost of power and, you know, energy, generally.

Mr. WALBERG. It is a pocketbook issue, isn't it?

Mr. PUGLIARESI. Yes, there is a pocketbook issue. There will be no—there is no political support for this, I can assure you.

I mean, remember, four pillars of modern civilization still do not have a cost-effective alternative, from a—from fossil fuels: steel, cement, plastics, and fertilizer.

Mr. WALBERG. Yes. So I guess what I am hearing you say is that, by cutting off existing pipelines, this will actually undermine a clean energy transition, as was the case in Germany. Am I correct?

Mr. PUGLIARESI. Yes, I believe we are going to see a great deal of public dissatisfaction with the winter crisis throughout the European continent. And it is already creating a lot of political divisions, and a lot of political turmoil.

Mr. WALBERG. To what degree do you think political decisions to shut down oil and gas infrastructure will impact energy prices, moving forward, as we recover from the COVID-19 pandemic?

Mr. PUGLIARESI. If we undermine our ability to efficiently produce, transport, and distribute traditional legacy fuels such as oil and gas, gasoline, propane, it is going to have a very negative political impact, because the American public is used to the reliability and the resilience of the system.

Mr. WALBERG. And the pocketbook issue comes back.

Mr. PUGLIARESI. It is a pocketbook issue.

Mr. WALBERG. Thank you, Mr. Chairman. I yield back.

Mr. SOTO. [Presiding] The gentleman yields back. The Chair now recognizes Representative Peters for 5 minutes to ask questions.

Mr. PETERS. Thank you, Mr. Chairman. I had a question for Mr. Zindler.

You know, different technologies have different demands for critical materials. We are talking about a lot of electric cars, which will take a lot of batteries, obviously. We are talking about using battery storage for—to deal with the intermittency of renewable energy. And I am wondering whether we should be making strategic decisions about which nascent technologies to support, given the amount of critical minerals they demand.

So in particular, should we be looking more aggressively at hydrogen for large vehicles, for buses?

Should we be looking more aggressively at things like advanced nuclear for power generation, because we may not be able to get all the batteries that we need for storage?

What do you think about the direction we should be taking, with respect to that scarcity?

Mr. ZINDLER. So it is a good question. And, you know, we used to hear a lot more about it an all-of-the-above energy strategy, I think, than we do now, even—frankly, even from Republicans. And yet it does seem like that—we really have major challenges in the short and the long term, if we think about this transition.

And longer term, you potentially do need technologies like advanced nuclear reactors. You need technologies like hydrogen to be used in various ways. And, like I said earlier, that is why, at least to me, it is encouraging that some of these are well supported in the infrastructure bill that passed recently. But you also need to support technologies that are more viable today.

But as Mr. Pugliaresi points out, I mean, you know, these industrial processes, there is no easy fix. And this is why hydrogen, for instance, or advanced nuclear, is important to try to find ways to decarbonize those areas, as well.

But in addition, there should be support for the technologies that are viable today. And I would note, really, that they are viable. And for—we can pretend that there isn't competition here, but the reality is that the number of electric vehicles that are being sold around the world has been surging, particularly this year. And I would argue that it is not just because there is policy support, though there has been that, but it is also because, ultimately, these are superior products.

So you can bury your head in the sand and say, "We just like internal combustion engine vehicles," but eventually there will be a transition.

Mr. PETERS. You are starting to address a different point. I mean, obviously, my concern grows out of the popularity of electric vehicles, out of the commitment of our—laudable commitment of our automakers to sell only electric vehicles—California, only electric vehicles after 2035, so it is our only emission-free vehicle. So I just think—I suspect we should be giving some thought to the effect of—scarcity of battery technology doesn't change, in particular.

Let me also ask you—so critical minerals are, obviously, a complex problem. In addition to the potential of onshoring recycling, it seems like we should be working with our allies to develop new mines and factories for clean energy technologies in more favorable

locations, like when we utilized the U.S. Export-Import Bank to help develop the world's liquefied natural gas market.

Can the U.S. collaborate with its allies to create more secure and sustainable supply chains for critical minerals and low-carbon technologies?

In other words, if we can't have it here, onshore it, can we friendshore it?

Mr. ZINDLER. I think the answer is yes. And, I mean, if you look at where the production of a lot of these elements are, they—both where they are, and where they could be, it is a pretty heterogeneous group of countries.

But where you look—if you look at where a lot of the refining of the elements takes place, the majority of it is in China. And so that is one area where you could say you would immediately potentially want to diversify, so that you have a greater—less reliance on these elements making a stop in China before they proceed along the value chain. And that certainly is, potentially, an area that our foreign development agencies could look at.

But the refining itself, to be clear, is something that could also be done in the United States. That is not contingent on a local resource of something under the ground.

Mr. PETERS. All right. Thank you very much for being here.

And Mr. Chairman, I yield back.

Mr. SOTO. The gentleman yields back. The Chair now recognizes Mr. Carter for 5 minutes to ask questions.

Mr. CARTER. Thank you, Mr. Chairman, and thank all of you for being here today. We appreciate your indulgence. I know it has been a long day, thus far, but we are almost home.

Mr. Pugliaresi, I want to ask you, this hearing today comes at a most appropriate time, because we are suffering from supply chain issues in our country. And, you know, whereas I think we can resolve these in the near term, I think it is a different story about the long term, and particularly when it relates to—when we are talking about supply chain of critical minerals.

And I know we have spoken about that today, you have, but I—you know, if all this were to go through, all these priorities, and these—with the Green New Deal and everything, you know, knowing how dependent we are on China, knowing how dependent we are on other countries to get these minerals, and knowing how long it takes to be able to get them here in this country if we were to be able to process them and to be able to get minerals here, what is the repercussions, both politically and economically, if we become so dependent on China for our critical minerals, if we were almost completely dependent on them for this?

Mr. PUGLIARESI. We are all going to suffer a strategic loss if we—if the components we need to transition to the fuels or the technologies of the future, or in—you know, regions in—which are unfriendly or subject to disruption.

If you think about the traditional way we thought about energy security, we were vulnerable in the petroleum—from petroleum, due to a concentration of low-cost reserves in unstable parts of the world, right? That imposed two risks on us. One, a few folks could get together and lower production and extract wealth from the United States; or two, right, there could be a major disruption. It

doesn't even have to be state actor. It could just be acts of terrorism.

But we were so dependent on that. And the emergence of the U.S. as a major oil producer in the world has virtually eliminated this problem. Yes, other players can do things, and this is the problem, if we try to transition too fast and too deep with these alternative, these alternative fuels.

Mr. CARTER. Thank you for mentioning that. I often cite just what you said. You are old enough, I am old enough to remember the late 1970s, when we were dependent on other countries, particularly in the Middle East, for our energy needs, and we knew it, but we realized it when gasoline got up to be $5 or $6 a gallon. And we did something about it. We set out to become energy independent, and we achieved that. We even achieved energy dominance.

And I remember our former Secretary of State, Mike Pompeo, saying that it was such a tool in his tool chest, when he could go worldwide, knowing that we had energy dominance, it gave us something that other people didn't have, and that we could utilize on a foreign playing field, if you will, and how important that was.

I want to get to something else, because I am really interested in this, and that is just how clean some of this stuff is. When we talk about clean energy, what about the waste?

And the title of today's hearing is, "Clean Energy Economy." But in your testimony you mention the high cost of materials and commodities needed to build enough clean energy projects that could replace the output of a natural gas plant. In fact, according to the Manhattan Institute, the energy equivalent of 100 barrels of oil, as used in the process, is to fabricate a single battery that can store the equivalent of one battery of—one barrel of oil.

How much cleaner are wind, solar, and battery technology, when they require so much more in terms of materials processing and land?

Mr. PUGLIARESI. Right. So one of the problems is we have kind of a unidimensional view towards the environment. Everything is focused on carbon emissions, and we forget about all the other things we need to worry about, which is land disturbance, how much land we are going to need, how much power and energy needs to be made to fabricate the steel for the windmills.

And I would like to thank Mark Mills for his excellent analysis of this problem, because there are no free lunches.

Mr. CARTER. Absolutely. And I appreciate you mentioning this. I represent South Georgia, a very rural area, and I have been—I have visited some counties where the state and Federal Government are offering tax incentives for them to switch for—from farmland to solar farms.

And let me preface and say, look, I am a big clean energy advocate. I am very proud that I was just—I just received an award, as a conservative clean energy person of the year in Georgia, and I take it very seriously, and I am all for clean energy. But I also want to be accurate, and I also want to make sure we understand.

But I was—what I was saying is some of these counties, we are using up ag land for solar farms, and some of the counties have

even put moratoriums on it now, because all of the ag land is being turned into solar farms.

Mr. PUGLIARESI. Well, if we are using a set of price signals which don't reflect the actual costs of production, and the actual value of the products, we are going to have these distortions. And so we should be cautious and careful about the pace at which we do these things.

Mr. CARTER. Again, I thank you all for being here. I just want to make clear—and I am a strong advocate for clean energy, but I want us to be—go with our eyes open on it, and make sure we understand just how clean it is.

Thank you, and I yield back.

Mr. SOTO. The gentleman's time has expired. Next the Chair recognizes Representative Dingell for 5 minutes to ask questions.

Mrs. DINGELL. Thank you, Mr. Chairman, and I thank both of our chairmen for holding today's important joint hearing on domestic supply chains for clean energy. This hearing couldn't come at a more critical time, as we look towards the future and American competitiveness.

We have seen over the last two years how a global pandemic can negatively impact our domestic supply chains, and we cannot afford to be caught flat-footed as we embark on this transformational shift to a clean economy. That is important for both American prosperity, but also for our national security.

And I just want to say I need to get to my questions pretty fast, because I care deeply about electric vehicles, but I am hearing my colleagues, who I have a great deal of respect for, make comments about clean air energy. I remember when Michigan went to renewable resources, how everybody was so worried about wind and solar, and how expensive it was going to be. And it has turned out to be far less expensive than anybody thought, and less than gas and oil.

And the Secretary of Energy is my friend, and I just have to—she is not laughing at anybody having to pay increased costs for anything. I think the—her comment was taken out of context. We all care about Line 5. We care about energy supply in the State of Michigan, but we also care about the Great Lakes, and what would happen in an oil spill. It is a far more complicated subject than a one-minute sound bite in our committee, and maybe we could get to that someday in committee.

But having said that, I would like to focus on the critical mineral supply chains needed to support electric vehicles, and how innovative companies are rethinking clean energy supply chains.

First of all, Mr. Zindler, in your expert opinion, do we currently have the robust domestic supply chains for critical minerals and processing needed to lead the world in the development, production, and deployment of electric vehicles to meet the President's 2030 EV goal? Yes or no?

Mr. ZINDLER. No.

Mrs. DINGELL. I agree with you.

Mr. ZINDLER. No.

Mrs. DINGELL. We don't have the supply chain needed, which is why I would like to explore the recent partnership announced between Redwood Materials and Ford.

So the recent collaboration between Redwood Materials and Ford—and, by the way, I agree with my—I am not old, but I am seasoned. I remember sitting in lines, and our dependency upon foreign oil, and we never want to get that way again. And China is making too many of our batteries, but we have the resources to do it here, and protect our own national security.

So Dr. Switzer, the recent collaboration between Redwood Materials and Ford to make electric vehicles more sustainable and affordable for America represents a partnership between an emerging—American company that are rethinking clean energy supply chains, and encouraging large companies, namely the automakers, to do the same. So can you speak on the innovative business models you are pursuing, for instance, on how Redwood is centering its business around circulatory, for those that—the domestic supply chain, and how the industry is reacting to this approach?

Dr. SWITZER. Yes, sure, thank you for the question, and highlighting our recent partnership with Ford Motor Company. You know, they have been very exciting to work with, as they really are forward-leaning, in terms of the electrification of their fleet.

When we talk about our partnership with Ford, it really is, you know—it encompasses all of what you said, as in circularity. We are interested in how do we, you know, collect and recycle Ford's end-of-life batteries from their electric vehicles they place on the market?

But not only how do we collect and recycle those. It is important that we also refine and then re-manufacture those into battery materials that Ford can use, here in the U.S., wherever their plants are.

Mrs. DINGELL. So can you—because I am going to run out of time already—talk about how that increases efficiencies in battery manufacturing, and how that helps us in American production?

Dr. SWITZER. Yes, I think that is a key point of it all, is that—you know, there has been a lot of talk today about how, you know, domestic manufacturing can't compete, whereas, as we would actually maybe contend the opposite. And I think that is why Ford is so interested, is that—you know, we think that, by bringing these material—this material manufacturing into the U.S., we can actually drive costs down, and help reduce the cost of the battery, which is the single most expensive component of an EV.

Mrs. DINGELL. I am out of time. I may, Mr. Chairman, with permission, do some questions for the record, and thank the witnesses, and yield back the balance of my time.

Mr. SOTO. The gentlelady yields back, and questions will be submitted for the record.

[The information follows:]**********COMMITTEE INSERT**********

Mr. SOTO. The Chair now recognizes Mr. Curtis for 5 minutes to ask questions.

Mr. CURTIS. Thank you, Mr. Chair, and thank you to our witnesses.

I recently arrived back from Glasgow, Scotland, where I attended COP. And I know what you are thinking. A Republican, right? Attended COP?

I had many fascinating conversations over there, and one of those fascinating conversations with—was with the president of Scottish Power. And he started our conversation by saying, "We are 100 percent renewable." And having run a utility before I couldn't let that go. I had to ask him more questions.

"Well, what do you mean?"

He said, "Well, we have so much wind. We don't know—you know, we have more wind than we can possibly use," and they have built an infrastructure around Scotland for—to capture the wind.

And so I asked the next logical question, which is, "What happens when the wind doesn't blow?"

And he said, "Oh, we have to import power, and it is usually from natural gas." And then he went on three or four more times to reiterate that he was 100 percent renewable, and didn't see that, at least in my mind, which was the catch to his claim.

The next day I had a conversation to speak with an organization that works in Scotland to balance power. So they take power coming in, and make sure that the power going out is equal. They actually pay homes to not use power, so that they can make it equal. And I brought up this because it was haunting me all day, this baseload issue, right, if you have got this much wind.

And the gentleman I talked to said, "You know, I haven't heard the word 'baseload' in five years." It is not even part of their conversation.

And so, as far as I know, it is a fact that we don't have the technology to store this type of renewable at scale. I get that we can do it, but at scale.

It is also a fact that their nation is dependent on outside energy from outside of their borders.

And it is also a fact that this vulnerability leads to unstable prices and uncertainty. As a matter of fact, I had a conversation where we learned of one woman who has a home —several hundred square feet—that was paying $1,000 U.S. for her utility bill. And we actually saw in that room, where they were balancing power, that power had doubled, tripled, and quadrupled as they became dependent on the natural gas coming into their system. I call this, the emperor has no clothes moment, something that happens, I think, a lot in these discussions.

There is other the emperor has no clothes moments, and one of those, to me, is the demonization of fossil fuels. It makes us feel good to shut down pipelines like the Keystone Pipeline. But the reality of it is, I believe, shutting down the Keystone Pipeline increases greenhouse gas emissions, because we simply use fuel from dirtier sources, or we truck that fuel in. As a matter of fact, in Glasgow they were joking that we should name the Keystone Pipeline Nord Stream III, and we could get it approved and passed.

Another elephant-in-the-room moment is the moratorium on Federal leases, which makes us dependent on China for critical minerals. We have talked about that today.

So we remain locked in a tug of war of words and ideology. I don't believe it needs to be that way. In fact, it is clear to me that, no matter your answer, renewables, emerging technologies like new nuclear, hydrogen, or fossil fuels, they all lack one major compo-

nent, and that is innovation. Every single one of those lacks innovation that it needs to be.

As a matter of fact, no matter who you talk to, when they say we are going to be carbon neutral by 2050, or we are going to cut that in half by 2030, they all put a little asterisk by it that says, "We don't know how to get there yet," and we are lacking serious innovation in these three areas.

So I asked myself and, in the few moments that we have, I would like to ask you, and I will start with Mr. Pugliaresi, what are the barriers to innovation right now, and what is keeping us from breaking through some of these barriers in innovation?

Mr. PUGLIARESI. First, you know, I think we sort of looked at what was happening with our iPhones, and silicon, and chips, and we said, "Well, we should be able to do this for energy." But in fact, these are a much harder problem. They bump against some fundamental problems of physics. And so we are going to have to invest a lot in research and development to make sure that the technologies we deploy are cost effective.

My biggest concern, from an energy security point of view, is that we begin to deploy technologies that are not actually ready to be cost effective, are not resilient enough, because we—our aspirational goals kind of exceed our sort of pragmatic views of the world.

Mr. CURTIS. We have also just heard recently about lifecycle costs, right, that we don't always look at lifecycle cost.

Mr. Zindler, I can tell that you have had a lot of good answers throughout this hearing, and I can tell there have been a lot of things you have wanted to respond to. I would love you to respond to this innovation gap, right?

And if we are not careful, this turns into a, you know, a Republican-Democrat fight. But I don't think innovation needs to be.

What are our barriers to innovation, in your mind?

Mr. ZINDLER. Well, I will try and be really quick, because I know we are at time.

But first, thank you for a really thoughtful question, and for your time in going to Glasgow. And I think you pinpoint a real challenge, which is long-term, long-duration storage is an issue, and it is one that we don't have solved now, and it is one that we need to invest in over the long haul.

Certainly, batteries that can provide—lithium ion batteries can provide, you know, short discharges, and help with cars and everything, but that is an area where we need to focus.

Mr. CURTIS. And I am going to cut you off, because the Chair is going to cut me off, and I know we are out a time.

Let me also suggest a level playing field and permanency, so that corporations can invest, knowing that they have got permanency.

And I hear your gavel, Mr. Chairman, I yield my time. Thank you.

Mr. SOTO. The gentleman's time is expired. The Chair now recognizes Representative Veasey for 5 minutes to ask questions.

Mr. VEASEY. Mr. Chairman, thank you very much. With electric vehicles poised to grow tremendously—and we are looking at here, and in Fort Worth, we are on the short list for a large electric vehicle company that is thinking about actually moving their headquarters here.

We, obviously, need to take seriously the sourcing of these materials, and not just, you know, gloss over them, and pretend like it is not a problem. But it is also critical that we are thinking and preparing for what to do with the materials at the end of their life.

Earlier this summer, with Representative Doyle, we introduced H.R. 4864, the Battery Material Processing and Component Manufacturing Act. And this bill makes billions of dollars of investments in building a domestic battery supply chain by focusing on material processing, component manufacturing, and recycling. I worked with my colleagues, and was pleased to have the bill included as part of the Infrastructure Investment and Jobs Act that was signed into law. The Department of Energy will now have the authority and resources to collaborate with the private sector on how to responsibly produce and process battery materials, but also invest in infrastructure needed to manufacture and recycle batteries here, in the U.S.

We heard today from Dr. Switzer about the importance of creating a closed-loop domestic supply chain for batteries, and I would like to give him the opportunity to add anything else he would like to on the importance of this type of collaboration.

Dr. Switzer, given your experience at Redwood working to build a domestic battery business, what further steps does Congress need to do to support and facilitate businesses like yours in building domestic battery manufacturing?

Dr. SWITZER. Thank you. I think, to start off with, conversations like this are a great place to, I think, bring everyone to that kind of level playing field, and to the same level of kind of education and awareness of the issues.

I think there has been, in terms of, you know, creating that closed-loop supply chain, there has been a ton of announcements and investment around the electrification of our automotive fleet. You know, the Big Three have all, really, leaned forward and said, "We are going to go electric," and I think that is a huge step.

And you know, in front of that, there has been a lot of investment in battery manufacturing, and a lot of announcements of battery manufacturers coming to the U.S. But I think in front of that is where we really need to focus. And in front of that is the battery material supply chain, along with, coupled with, the recycling supply chain that needs to kind of close that circle such that, you know, once the materials are here in the U.S., they stay here in the U.S., and can be re-manufactured, essentially, an infinite number of times to produce new batteries over time.

Mr. VEASEY. No, yes, yes, thank you very much.

And before my next question, I just want to say, Ms. Brown, thank you, in your opening comments, for really projecting some reality into this conversation. I thought that that was very much needed. And I am going to move over to my state of Texas.

Many people on this call know, because I have talked about it a lot, that we are—not only are we the leaders when it comes to producing oil and gas, but we are also the leaders when it comes to wind energy in this country. We are showing the rest of the world and the rest of the country on exactly how you can wind, and no one can argue that.

And we have quite a bit of solar power, as well, but we often have a problem with matching generation with load. Energy storage technologies will be a key part of shifting energy when it is cheaply generated to when there is demand on the grid.

Another provision in the infrastructure bill just signed into law would establish a demonstration project for second-life applications of EV batteries—aggregated energy storage installations on the grid. It is estimated that lithium ion battery packs in EVs may retain about 70 percent of their storage capacity at the end of the battery service life to the vehicle. Mr. Zindler, can you speak about how recycling EV batteries for use on the grid might complement the deployment of clean energy, particularly in a state like Texas?

Mr. ZINDLER. It is a good point, and it is a good question. So yes, we have started to see some of the recycling of some EVs to be used for storage.

My understanding is it is a little less—so what you might traditionally think of as on the grid, but in the so-called behind-the-meter sense. That is, in people's homes and businesses, where they want backup power in the case of outages. And I think there has been something like 40 or 50,000 of these systems sold in California, in particular, because of all the outages they have had around wildfires. So the demand for residential storage is definitely growing, and there is a potential that these batteries can be used in that application.

Mr. VEASEY. Thank you very much.

Thank you, Mr. Chairman. My time has expired.

Mr. TONKO. [Presiding] The gentleman yields back. The Chair now recognizes the gentleman from Indiana.

Let's see, Mr. Pence, you are recognized for 5 minutes, please.

Mr. PENCE. OK. Thank you, Mr. Chairman. Thank you, Chairs Tonko and Rush, and Ranking Members McKinley and Upton, for holding this hearing today, and thank you all for being here. I found it very informative, just to be here and listen to what you all had to say.

Mr. Pugliaresi, I know that you share my concern that Hoosiers and all Americans are struggling to keep pace with rising energy prices. That is really all I heard back last week, when I was out in the district. It is the number-one issue, the inflation and—particularly having spent an entire career in the petroleum distribution industry, they put their price right out there, so everybody knows whether the price went up, and they are really getting out of control, and affecting manufacturers, transportation industry.

I agree with you that the Biden Administration policies, such as a halt on oil and gas leasing on Federal lands, duplicative emission regulations, and the war on pipeline projects, such as the Keystone XL, have undermined our energy independence and contributed to a global energy crisis, because crude oil is an international product movement.

While I support an all-of-the-above approach, like my peers have all talked about today, this hearing has only further proved that oil and gas remain necessary to maintain energy independence, particularly when we don't have the storage technology at this time to really move it forward in an expeditious way. And I hope my col-

leagues are listening to what a number of the folks have testified about today.

You know, here is where I am going, sir. Innovation has been a hallmark of the petroleum industry ever since I—my family was involved in it. And it—should we just abandon support of the oil industry at this time, when they have shown so much improvement in the environment, in cleanups, and things like that?

Mr. PUGLIARESI. So, you know, I think one way to look upon it is that these legacy fuels, particularly oil and gas, they provide—they are extremely valuable. And we know that because they are—they generate large sums of revenue directly to the Federal Government.

You take our leasing system between 2005 and 2015. Over $110 billion flowed directly to the Federal treasury. A lot of it was distributed back to the states. In that same period, we probably spent over $50 billion for grants and production tax credits for wind and solar. I am not saying it is a bad idea, but I am saying this gives us a signal in the marketplace, in the valuation of this commodity within our system.

We have a lot of extra economic value, if you like, showing up. It is because consumers want it, it has the characteristics that they need. And that is not the case yet for wind and solar. It is competitive. I am told it is competitive, but we will know more when we see the industry, the wind and solar industry, say, OK, let's give—we don't need the tax credits any more, we don't need the production credits—

Mr. PENCE. You are right, you are—

Mr. PUGLIARESI [continue]. We are ready to bid on land values in the—on public lands, just like the oil and gas industry.

Mr. PENCE. Well, and not only the lease revenues of 110 over a 5-year period, but also motor fuel taxes on a Federal level are about 51 billion a year, and you could at least double that for the impact between motor fuel for state taxes and then sales tax. And that is a lot of income that would disappear out of the system.

But back to why would we not continue to support or enable the industry to innovate and improve technologically, like they have for so many years, is that something we are not talking about now?

Mr. PUGLIARESI. Apparently not. But the real question is the pace at which we transition to these fuels of the future. And the most troubling aspect of a lot of policy discussions, and some policies, is that we are abandoning these high-valued fuels before we really have cost-effective substitutes. And that is a prescription for a lot of problems.

Mr. PENCE. Yes, sir, and thank you for that. You know, I am really concerned about the average consumer in the Indiana district that I represent—of course, across the State of Indiana. And I appreciate that we do figure out to do an all-of-the-above without hammering and doing it at the expense of the constituents that I represent.

So thank you, Mr. Chair. I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentlelady from California.

Representative Barragán, you are recognized for 5 minutes, please.

Ms. BARRAGÁN. Thank you, Chairman Tonko, for holding this important hearing on supply chain solutions for the clean energy economy. It is important that we work toward having a robust, clean energy supply chain that is not dependent on countries with poor labor and environmental standards, especially rivals like China.

Mr. Zindler, this year we have seen the importance that ports and investing in ports and freight infrastructure has on keeping goods moving efficiently throughout our country. How are ports important for supporting our clean energy supply chain?

And how can investing in domestic clean energy manufacturing create jobs that uplift ports and surrounding communities?

Mr. ZINDLER. I apologize, I had a little trouble hearing that. Could—would you mind repeating the last—very quickly, just the last bit?

Ms. BARRAGÁN. So how are ports important for supporting our clean energy supply chain?

And how can investing in domestic clean energy manufacturing create jobs that uplift ports and surrounding communities?

Mr. ZINDLER. OK. So in the short run, ports are tremendously important. And one of the reasons we have seen a squeeze on pricing in the cost of solar equipment and other areas of clean energy is for the same reason we have seen around other things that are putting inflationary pressure on, which is that—the ability to get stuff into the U.S. has been challenged.

Longer term, I guess my honest answer would be that, if you build more domestic manufacturing, you wouldn't need to import as much. There is, of course, the potential that eventually the U.S. could export. But I think we are a long way from getting there.

Ms. BARRAGÁN. OK, thank you for that.

Ms. Brown, in December of 2020 a community labor coalition, including the United Steelworkers Local 675, joined with the electric bus manufacturer, Proterra, to announce a community benefits agreement to support union jobs in their manufacturing, with at least 50 percent from disadvantaged communities. This shows the promise of a clean energy economy that we are aspiring to.

What policies can create the conditions for these types of community benefit agreements throughout the country for energy manufacturing?

Ms. BROWN. Thank you for the question, Congresswoman. We are really proud of that, again, partnership. I keep using that word today, "partnership," between our union and Proterra and the community to achieve that community benefit partnership.

You know, and I think it really goes back to tying really high-value standards to our policies. You know, we talked earlier about domestic content requirements, but tying labor standards to our policies also help to ensure these types of arrangements and agreements. And so that is really where we focus, is strengthening our policies by layering on stronger standards.

Ms. BARRAGÁN. Thank you.

Mr. Switzer, there is a lot of untapped potential for recycling the critical minerals used in electric vehicles, both in production and when they reach the end of their useful life. What are the right requirements and incentives to ensure we are not burying critical

minerals in landfills and scrap yards, given the need will be so great?

Dr. SWITZER. Yes, thank you. I think, you know, I think, one, supporting the battery recycling industry as it stands up, and as it demonstrates that we can think of these batteries coming out of vehicles not as not as liabilities, but rather as actually assets that have value that can then be reused and manufactured into new battery materials.

And to your question on ports, I would, you know, just second the comments around, as we stand up the recycling industry here in the U.S., and as we stand up the battery materials industry here, in the U.S., we will be less reliant on importing material. And I think that is critical, going forward.

Ms. BARRAGÁN. Well, thank you, and thank you to our witnesses today for being here.

We have to look ahead, and we need to look at the future. And, you know, there has been just so much talk about, you know, worrying about concerns in other countries, not looking at the concern right here in our own backyard of what is happening to our communities that are either communities of color, low-income communities that are living next to these fossil fuel burning sites, the health impact it is having, and nobody is putting a value on human life, and what is happening in our communities. So I do thank the chairman for the hearing today, and we have got to make sure we continue to build on the infrastructure bill, and passing the Build Back Better.

And with that, Mr. Chairman, I yield back.

Mr. TONKO. The gentlelady yields back. The Chair now recognizes the gentleman from Alabama, Representative Palmer.

You are recognized for 5 minutes, please.

Mr. PALMER. Thank you, Mr. Chairman. I want to talk a little bit about supply chain. And, obviously, our supply chain consists of rail, and truck, and shipping, airfreight, but it also consists of pipelines. I just want to know how much sense it makes to shut down Line 5 in Michigan, and potentially the pipeline into Missouri providing natural gas that, I think, originated from Mercatus—not Mercatus, from the Marcellus shale formation.

Does that make sense, Mr. Pugliaresi?

Mr. PUGLIARESI. No, as we have discussed previously, there are enormous strategic and direct economic benefits from having the entire North American production platform as efficient and as cost effective and as safe as possible. And we lose those benefits when we try to make that platform less efficient.

Mr. PALMER. Let's talk about how it is going to impact people, though. A lot of what we discuss here is just kind of politics, and technical, and I am not sure if—how many people really reflect on how it actually impacts people.

But we are on pace to face the biggest surge in electricity costs since the Obama Administration, and it is a direct result of the Biden Administration's policies. And I kind of think that maybe they learned it from the Obama Administration, since he served as Vice President in that Administration. It is going to be the costliest winter on—in decades, I think, maybe, but certainly in years, for households that are not only going to be hit with high household

utility bills, but they are going to get hit with much higher costs at the pump.

As a matter of fact, there was a Canadian study that showed that, when you take into account gasoline prices plus the increase in household energy costs, that we are talking - the bottom quintile, the lowest 20 percent of household incomes, paying almost 19 percent of their household income, just on energy. That is going to have a devastating impact on a lot of lives.

And one of my big concerns—and here is a study from Northwestern University Department of Economics on how inexpensive heating reduces winter mortality. And I brought this up in the committee before, and I have yet to hear from one of my colleagues across the aisle express the same concerns that I do about the number of people who are going to die this winter because they can't afford to adequately heat their homes. We know it is a scandal in Europe.

Mr. Zindler mentioned all these nations that have gone to renewables, and I looked at the ones who have gone to solar and wind, and there is 30 nations that—and most of them in Europe—as a matter of fact, I think all of them are in Europe—that are reporting excess winter deaths, and the United Kingdom is sixth. And they had 9,700 people die last winter because, you know, they had respiratory issues, they had cardiovascular issues, and that really, really hurt people when they can't afford to adequately heat their homes.

Are you aware of that, Mr. Pugliaresi?

Mr. PUGLIARESI. I don't have the recent data on the deaths, but let me just say, for large segments of the American population, rising energy prices are devastating, because it does become a large percentage of their income.

We did a webinar on the Transportation Climate Initiative and, in fact, it was—you know, sort of the Northeast states. And a primary concern from state legislators was, well, we are interested in this, but we don't want to see low-income families hurt.

Mr. PALMER. Well, it is really going to hurt people in the Northwest. I looked at Vermont, and the people in the lowest quintile, their average household income is less than $28,000, 18.3 percent—I mean, in that—they pay 18.3 percent of their total income. That is 7 times more than the people in the top 20 percent of household incomes in Vermont.This is going to have a devastating impact on people living in those colder climates.

And I am going to get into some other stuff later on, but when you combine this with inflation that we are already experiencing, and the fact that energy costs are the most inflationary component of the economy, we are, literally, condemning some people to death. And I just think that there is a cost that is not being calculated here that, apparently, my colleagues across the aisle are not that concerned about, but I certainly am, and I am going to speak up for those people.

With that, Mr. Chairman, I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from Florida.

Representative Soto, you are recognized for 5 minutes, please.

Mr. SOTO. Thank you, Mr. Chair. The challenge. Climate change is an existential threat to the human race. In Florida we are facing intensifying hurricanes, rising seas, and the hottest years on record. But there is hope.

The goal? Reduce greenhouse gases by 50 percent by 2030, and get to net zero by 2050.

The way we are going to do it? A hundred percent clean electricity by twenty-thirty-five.

We are at 40 percent right now. Nuclear, 20 percent. Renewables, 20 percent. The fact that people are saying we can't get the other way with 60 percent—yes, we can, and 50 percent electric vehicles by 2030.

And Congress is leading the way, with the Build Back Better infrastructure package, which has billions for electric vehicle infrastructure and clean energy. I want to thank both Representatives Upton and McKinley for joining the Senate, and making this a bipartisan bill.

America must lead the way on this.

And I also want to thank Representative Curtis for joining so many of the Democrats over at the COP. It shows that we can work together in a bipartisan fashion.

There are other challenges expanding the clean energy supply chain, which is what we are here for today: microchips; rare Earth metals, which, by the way, we could utilize both coal and coal ash to develop rare Earth metals, a great way to help in this transition; we need to grow wind and solar by four times what we have right now; we need next generation batteries and modular nuclear; and yes, we need carbon capture, too.

We also must acknowledge the pain suffered by so many of our constituents with rising gas prices. You know, in August, NPR had a headline. Hurricane Ida hit an important oil and gas hub in Louisiana, which will likely drive up gas prices. And that is exactly what happened. Climate change supercharged a hurricane that then incapacitated many of our refineries in Louisiana, causing rising gas prices. Climate change is helping cause this to happen. If we do nothing, it will happen again. It will get worse.

And then inflation. A critical question and a critical quote. Senator Rob Portman said yesterday, when we were at the bipartisan infrastructure signing, that the bill represents long-term investments in our nation's hard infrastructure assets, create hundreds of thousands of jobs with the bill, make us more efficient and competitive against countries like China. It adds to the supply side of the economy, and will be counter-inflationary. It will be counter-inflationary at a time of rising inflation, and it does it all without raising taxes on the American economy. That is from the good Senator from Ohio, and I happen to agree with him.

The rest, who voted no, put party over country, and the American people know it.

Also missing from the talking points of today, we had an impressive 521,000 jobs in October. Unemployment is down to 4.6 percent, and in Florida it is under 5 percent, as well. COVID cases are way down nationally, and children 5 to 11 can now be finally vaccinated. So what is the headline? In short, jobs are up, COVID cases are down, and children are safer.

Improving the supply chains are part of this critical effort to combat climate change. So the big question for this committee: Can we work together, in a bipartisan fashion, to get this done? I know we can.

Mr. Zindler, the solar supply chain currently relies heavily on other countries, including China, as we attempt to build a domestic solar manufacturing supply chain. What are the places we should target, and what parts of the supply chain are easier to support and establish leadership?

Mr. ZINDLER. Thanks for the question.

The—first, as I said in my testimony, the U.S., essentially, at the moment, is a non-player in the production of crystalline silicon modules. And the easiest part of the value chain to address is the final assembly of those modules, which is, literally, putting them together. But that is a relatively low-value process, and can be kind of done anywhere.

The real value is further upstream, when you look at the production of the cells, and the wafers, and even the polysilicon production all the way at—near the beginning of the process. And so that is—those are all areas which China is clearly leading in, and those are areas that could be supported further, and brought onto the U.S. shores with the right policies.

Mr. SOTO. Thank you. My time has expired.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from Texas.

Representative Crenshaw, you are recognized for 5 minutes, please.

Mr. CRENSHAW. Thank you, Mr. Chairman, and thank you to the Chair and ranking member for holding this important hearing.

I am going to state the obvious. To improve the so-called green supply chain, you first need to fix the actual supply chain. The former cannot exist without the latter, obviously.

And this supply chain crisis didn't come out of nowhere. This is a self-inflicted wound, a direct result of bad progressive policies. Mandates to overregulation, the tax on American energy have compounded every single problem we are facing today, from record-high inflation, to slow economic growth, to shrinking labor force participation, and, potentially, an energy crisis.

Policies have consequences. Locking down businesses, though shown to have little impact on the trends of the pandemic, had a huge impact on employment and economic growth and, yes, supply chains. A year later, we are still dealing with that.

Vaccine mandates threaten to scare off employees in every industry, from logistics to ports to shipping. The head of the National Association of Wholesale Distributors put it this way: "Thousands of valued employees will be forced out of their jobs shortly before the holidays. The already compromised supply chain will be under added pressure during the busiest time of the year, and the already tight labor market will make it immeasurably more difficult to replace laid-off employees, compounding supply chain disruption."

In California, where the bottleneck at our busiest port is exacerbating this crisis, their version of the PRO Act, which Democrats passed out of the House this year, and which bans independent contracting, threatens to destroy the trucking industry. Those

truckers are freelance owner-operators, which California outlawed by banning independent contracting. Truckers sued California. But if they lose, their industry will be decimated in the midst of this supply chain crisis.

It also seems as if President Biden is doing everything in his power to make energy less affordable and harder to come by. On day one President Biden shut down the Keystone Pipeline, of course while also asking OPEC to increase their production.

The Democrat Party seems intent on nationalizing the failed energy policies of California, where the price of electricity has risen six times faster than the rest of the country. The attack on oil and gas has put a chilling effect on investments in new production to the benefit of global competitors like Russia.

These policies impact the poorest Americans the worst. As energy prices rise, more Americans sink into poverty. Every 10 percent increase in energy costs leads to 840,000 Americans falling below the poverty line.

Now, instead of holding a hearing to examine how we can fix the supply chain crisis, deal with skyrocketing energy costs and unprecedented inflation, we are here to talk about the clean energy supply chain. And this strikes me as a bit of a joke, a joke because, in response to the worst supply chain crisis in our lifetime, the President has offered an executive order to move clean energy manufacturing back to the United States.

Now, here is the problem. Every single component in wind turbines, and solar panels, and electric vehicle batteries is made with the raw materials that Democrats say are destroying the planet. So which is it? It seems to me that, when Democrats said they will create green jobs, they apparently mean green jobs in China, because they will never allow the rare Earth mining and refining and processing necessary to make those things here.

Wind turbines are made with 75 percent steel, which is, at its most basic, iron core plus carbon. They are made with resin, which comes from natural gas. They are coated in chemicals like PFAS.

The Democrats have made mining so politically toxic, that we now only have seven remaining iron ore mines in the United States, despite having three billion tons of iron ore in the United States.

Democrats have turned natural gas into the enemy, threatening to tax it out of existence in the reconciliation bill, even though natural gas is the single largest reason for carbon emission reductions in the United States. Solar panels and batteries require critical minerals, but Democrats, even in the Build Back Better Act, impose staggering royalties on both new and existing hard rock mineral projects, despite the fact that these minerals are crucial to the Biden Administration's own clean energy goals.

Even if we could build all of these new renewable power sources, we would need vast amounts of transmission lines and, therefore, copper to transport it. In fact, experts estimate copper demand will double by 2040. But guess what? The Democrat reconciliation bill specifically shuts down the Resolution Copper project in Arizona, which could supply up to 25 percent of domestic copper demand, and provide almost 4,000 jobs.

And can we please stop pretending that we can meet the demand for rare Earths by recycling more? The testimony presented here today has already debunked that false narrative, showing only a fraction of our needs could ever be met by recycling, not to mention separating and recycling rare Earth metals takes enormous amounts of heat, something impossible to produce with renewable energy.

So my point is this: policies have consequences, and progressive policies are hurting Americans. We can fix this by giving businesses some breathing room, calling off the attacks on American energy, and rescinding unconstitutional vaccine mandates. But instead, we hear about the fantasy of green supply chains that can never be built, ironically, because of the barriers put in place by progressive policies.

Thank you, and I yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from Arizona.

Representative O'Halleran, you are recognized for 5 minutes, please, for questions.

Mr. O'HALLERAN. I want to thank the ranking members and the chairmen for this hearing.

You know, it has been an interesting discussion today. But if we are going to move forward, we have to move away from these type of discussions and on to something that is more recognizing of the future of our country and our world, and where we are heading. Fear of change has a tremendously negative effect on our public policy. We have to change, we know we do.

I have heard a lot in the discussions today about the concern for cost. I have that same concern. But it is also costly in health care today. It is also costly in addressing the—and recognizing the ongoing—the tremendous amount of natural disasters that are occurring in our world.

Arizona has seen consequences of climate change, up close: record wildfires, terrible droughts, extreme flooding. These are all costly.

Now, the best way we can cut carbon emissions is to encourage the development of clean energy. We should not be restraining innovation. We should be investing in the future.

And we should also recognize that many, many lessons in history has identified clearly that protectionism is not the course to the future. Recognizing what we have done right is a good idea. Recognizing that we should not move into the future is a bad idea. And these investments in new American jobs and economic activity around the country are needed. However, bringing new energy sources online is not a simple switch. We should recognize that also.

But we should plan for it. We should work together on this. We shouldn't have these types of discussions, where it is one side against the other side. We, as Americans, should learn from what our businesses, great businesses in America, have taught us: work together to find solutions that will work for the common good of the American people.

I have heard the witnesses today. This transition requires a careful, long-term planning process that we must ensure that we are

equipped to handle increased demand, and this means investments in grid modernization. That is what we are trying to do.

And this also is a national security issue. We can't rely on China to build our nation's energy infrastructure. That is just the wrong way to go. We need reliable supply chains, and we need to recognize the need of the American people, their health, their safety, their future, the cost of energy in our country. We need to come together to do that, though.

Dr. Switzer, securing our energy infrastructure remains a top priority. In our opinion—your opinion, I should say, how would producing clean energy components in America help protect our energy infrastructure from attack, versus the current path of buying these components from other countries?

Dr. SWITZER. Thank you for the question. I think, you know, investing and building out this battery supply chain here in the United States will serve several benefits.

One is that it will provide stability. I think it will also provide supply chain security.

Two is that I think we have to realize that these investments are happening, and they are going to happen elsewhere if we don't invest here in the U.S. They are going to happen not only in China, they are happening in Europe. They could easily also happen in Canada. I think there is a tremendous opportunity for us to leverage, and kind of be proactive in seeking to build that supply chain here, in the U.S.

And then lastly, you know, along with this, I think we can't underestimate the number of jobs that come along with this industry that aren't necessarily tied to a particular resource that are almost location agnostic.

So those are the reasons why I think it is very important for us to focus on building this supply chain here, in the U.S.

Mr. O'HALLERAN. Mr. Chairman, I am really concerned about the direction that we have taken in the past. Not this committee necessarily, but our country, as to hold back on recognizing the future, hold back on not creating the changes necessary, and try to protect the ongoing mistakes that we have made over time in not recognizing. Many corporations and businesses in this country have failed, because they have failed to adapt to an ever-changing environment, and that is what we live in, an ever-changing environment.

And we need to make this change. We need to do it together. And we need to also recognize that we have wasted so much time that some of the reasons why we are in a position we are with China and other countries is because we have failed to act fast enough.

Thank you, and I yield.

Mr. TONKO. The gentleman yields back. The Chair now recognizes the gentleman from North Dakota.

Mr. ARMSTRONG. Thank you——

Mr. TONKO. Representative Armstrong, you are recognized for 5 minutes.

Mr. ARMSTRONG. Thank you, Mr. Chair.

Technology and research R&D, we will support that. But if you think, when the government gets involved in picking and winners and losers we do a good job, we don't. We never have. It doesn't

matter if it is in clean energy, or banking, or health care, or tech, or oil and gas, or anything else. So we need to be able to deal with this, and we need to be able to deal with the short-term problems and the long-term solutions.

We can produce rare Earth metal here, we can mine it. We can produce more and more of these products that we use for renewable energy. But we can't get it done in the timelines that are being put out, and we can't do it done (sic), because we continue to have hearings, and will continue to move forward, but we don't talk about the barriers that exist.

We talk about infrastructure build-out for batteries, or technology that is going to replace lithium for long-term storage. When that happens, that will rival the microchip as to what happens with our economy. I agree with that. But we are not there, and we don't know when it exists.

And we don't have to go very far to look at how these things work. I will go on with what my friend, Mr. Crenshaw, said. We have been talking about the supply chain, our current supply chain and the issues we have with it, in my office since I got here. And actually, long before, in the state Senate. We are seeing today that ports along the West Coast is a problem years in the making that have only been exasperated by policies and programs pushed by the majority. Before we can consider the policies necessary to support massive expansion and build-out of supply chain specifically for renewables, we have to continue to face the problems we have in our current supply chain.

And the first thing we need to understand is supply chains are not linear and independent, not, they never have been. A change in input or output at any other point in the process will cause distortions that quickly and easily spread to the other networks. We know this.

North Dakota is the geographic center in North America, and we care very much about what happens at ports. Take trucking. Trucks haul more than 70 percent of our domestic cargo shipments. Companies, large and small, have been pleading for years to help address the fact that we cannot hire enough truck drivers to meet the ever-increasing demand.

Making things worse are inflexible hours of service and other regulatory requirements that don't accurately reflect the needs of modern logistics. But don't worry, they don't make the roads any safer.

Should we shoehorn massive new, renewable supply chains into a system that already has difficulty meeting current demands to move goods from point A to B?

And the House majority's PRO Act only looks to further complicate this picture, particularly when you are trying to on-source things, and keep our costs low, at a reasonable level with an international community.

Unless this Administration and the majority change course, our supply chains will be made less reliable, less affordable, and more prone to disruption in the short term. And we cannot solve our long-term problems if we don't take care of what is going on in the short term.

Mr. Pugliaresi, your testimony states that financial data does not support the claim that oil and gas companies are holding stranded assets. Can you explain that?

Mr. PUGLIARESI. Yes. So we have got a little help from Professor Tice with this one. But if you look at investment-grade bonds, particularly in the sort of oil and gas companies, the shape of those—what we call the yield curve, it suggests that these are the most—these tend to be the very, very conservative investors. The shape of the yield curve suggests that these assets are not viewed as risky.

I will keep it as simple as possible, but I really think this is an important point, because you hear a lot of commentary that, oh, oil and gas assets are going to be stranded. Well, and they will be stranded if people are going to plan to stop using them. I accept that. But, in fact, what we learned from the bond market is that is not what the market believes. The market believes those assets are quite valuable.

Mr. ARMSTRONG. Do you agree that the greater risk to secure and affordable energy and, thus—I mean, essentially, our entire economy at this point in time—are policy decisions that disincentivize capital allocation to traditional fuel supplies and production?

Mr. PUGLIARESI. So I am really—we are very much concerned about the ESG guidelines, which abdicate to financial institutions decisions about what prominent and valuable fuels they should invest in or not invest in.

I actually think this is a risk for the financial companies, because they are going to own this. If this goes belly-up for them, and there is a crisis, and they—and the sort of blame is on them, they are going to own this. And I really think this abdication by the government—the government should set the standards for what kinds of environmental controls we are going to have or not have, and that the banks should be—care about their shareholders.

Mr. ARMSTRONG. Well, I actually agree with you. I think eventually what ends up happening with the ESG portfolios is very much that, where they end up making their money, and where they come back, because that is how the market will react to it.

And with that I will yield back.

Mr. TONKO. The gentleman yields back. The Chair now recognizes, virtually, the gentlelady from Washington State.

Representative Schrier, you are recognized for 5 minutes for questions, please.

Ms. SCHRIER. Well, thank you so much, Mr. Chairman, and thank you to our witnesses. I have been listening attentively, because I am extremely interested in our transition to clean energy production and storage, and a broad rollout of electric vehicles. I am also interested in how we can make this transition to domestic sourcing and manufacturing truly work.

And I look at the nations that are currently leading in mineral sourcing, and the production of solar panels and batteries, and an increasing reliance on those countries is not in our country's best interest, nor is it in the planet's best interest. And that is one of the reasons why the U.S. needs to take a leading role in sourcing and manufacturing for our own economy, for the environmental

stewardship that we need, and also for ethical working conditions, so we can establish our leadership position in the world.

Now, onshoring sourcing and manufacturing, it is going to create family-wage jobs. And by sourcing materials here and recycling them, we won't need to depend on dirty mining in China or child labor in Africa.

Now, earlier in this hearing you answered Ms. DeGette's question about the necessity of mining here in the U.S., and you pretty much all agreed that it would be necessary to some degree or another. But even though mining is cleaner in the United States, minimizing the amount of mining that we need to do makes it even cleaner. And so, to minimize mining, we are going to need a robust recycling infrastructure of lithium, cobalt, copper, other elements, right here at home.

And so, Dr. Switzer, I have some questions for you. I would love to dive into this topic a little bit more.

First, just a lay of the land. Can you tell me what the current is state of recycling of these materials, like, from phones, computers, solar panels, lithium batteries, televisions right here in the U.S.?

Dr. SWITZER. Sure. So, you know, at Redwood Materials, I think I can highlight that we were founded in 2017 and, you know, already today, it has been a period of rapid innovation. We are recycling enough materials for roughly 45,000 vehicles a year, and that is in short order. And I think, over time, we will continue to expand that.

The key advantage of recycling is it is not something that is depleted over time, it is something that actually grows over time. So, as more vehicles are placed onto the market, that recycling resource only becomes greater and greater.

You know, today we are able to recover, you know, roughly, let's say, in terms of the nickel, and cobalt, copper, and lithium, way greater than 90 percent. I would go upwards of 95 to 98 percent of those elements we can actually recover and reuse from the batteries.

And that is not to mention——You know, another thing that was mentioned, just to highlight, was copper. Copper we actually export from the United States today. We export roughly 800,000 tons of scrap copper from the United States today, when there is a drastic opportunity to build a copper foil manufacturing supply chain for batteries that consumes some of that copper we are giving away today.

Ms. SCHRIER. I really appreciate your noting the issue of copper, and how we are exporting it and shoring up other economies instead of our own.

I also—I am intrigued. You said earlier today that right now your capability is enough for 45,000 cars. You are looking at a capability of six million cars in the future. I guess the other question is, yes, you can extract 90 percent back. But what about—how many of those batteries are coming back to you?

How many—I mean, how many of these things are ending up in a recycling facility, as opposed to in the trash?

I just want to make sure we have the infrastructure everywhere, so that we consistently get 90 percent out.

Dr. SWITZER. I think, in terms of EVs, we will certainly get the batteries back. I mean, these are—you know, we are seeing OEMs like Ford take—really, take interest in how to get those batteries back, because they recognize the inherent value in them.

I think where the challenge comes is in consumer electronics. You know, today, if any of us have a cell phone or, you know, a laptop battery that we need to recycle, it is not easy to figure out what to do with it, where to take it, who to give it to. And it gets even more complicated when you talk about consumer electronics devices with batteries that aren't designed to be removed. Things like electric toothbrushes, you know, how do we recycle those?

So those are some of the challenges that we are trying to tackle. And to highlight, though, is that we really do need to focus and build out that collection infrastructure, so that it is easy for folks to turn those batteries back in, so that we can recycle them and extract the valuable metals contained therein.

Ms. SCHRIER. I appreciate your saying that, because sometimes we have to pay to get them recycled, or wait for a big drop-off day in our neighborhood to get them recycled. And so I just know that, as a Member of Congress, I am excited to work with you and with the industry to make sure that it is easy, and that we can get all of that material back, and limit how much extraction we have to do here at home.

Thank you very much, I yield back.

Mr. TONKO. The gentlelady yields back. I now recognize a member from the Subcommittee on Environment and Climate Change, virtually, being Representative Blunt Rochester.

The gentlelady from Delaware, you are recognized for 5 minutes, please.

Ms. BLUNT ROCHESTER. Thank you, Mr. Chairman, and chairs, and ranking members, and to the witnesses for your testimony today and your patience.

As the founder and co-chair of the bipartisan Future of Work Caucus, one of the areas I have been focusing on is what we can learn from the pandemic's ongoing impacts on our economy, and how we can build an economic future that is more resilient, sustainable, and equitable for all Americans.

We are in the midst of a climate crisis, and the need to transition to clean energy has never been more necessary. Not only is this transition essential to protect human health and the environment, but it is also an enormous opportunity to strengthen our domestic supply chains and grow onshore, renewable energy manufacturing.

Last month I introduced two bipartisan pieces of legislation with Representatives Malinowski and Kinzinger: H.R. 5495, the Building Resilient Supply Chains Act and H.R. 5492, the Manufacturing Economy and National Security Act. These bills take crucial steps to stabilize our supply chains by providing financial support to develop, diversify, and expand our domestic supply chains.

The Building Resilient Supply Chains Act would establish a supply chain resiliency and crisis response office within the Department of Commerce that would help address shortages of critical goods and services, industrial equipment, and manufacturing technologies.

Mr. Zindler, why is it so important for the United States to invest in programs aimed at securing and fortifying our supply chains, especially for clean energy technologies?

Mr. ZINDLER. Well, to be honest with you, I am an energy industry analyst, not a policymaker, so that is really a decision for all of you to make.

But I can just sort of tell you the facts, which is that, at the moment, that if, you know, the U.S., you know, is going to install roughly 30 gigawatts of solar capacity this year, and I am guessing 80/90 percent of it will be imported goods, so—and that market is poised to grow, and so the question is whether or not U.S. policymakers are—that is something you want, or if that is something you would like to adjust.

So the reality of it is that, for these strategic areas, you know, there is a lot of imported goods that are being installed every year.

The one difference I would make is that, you know, once you do install the equipment, it is here. It is not like oil that you burn, and then it is gone. You know, you have the assets locally. You may have gotten them from abroad, but they end up here permanently.

Ms. BLUNT ROCHESTER. Thank you. And we appreciate your facts.

Representatives Malinowski and Kinzinger and I took important steps in crafting this to try to stabilize our supply chains, while strengthening our national and economic security. And during the pandemic we saw those vulnerabilities. How can a heavy reliance on foreign goods pose a threat to our economic and national security?

And how can a greater focus on onshoring clean energy supply chains support national security?

Mr. ZINDLER. Well, again, I would leave that to all of you, ultimately.

But, you know, realistically, you know, having the closer access to the supplies strikes me as a good way to ensure that, if you need to continue to manufacture new automobiles that are electric, that you have that stuff locally, if you do everything from the mining to the refining, et cetera, here, domestically.

But I would just caveat that slightly in saying that I know there has been a lot of talk about energy security and energy independence. To me, it is more about—I guess security is probably the better term because, you know, we live in a big world, in which a lot of the most important energy components and elements we need are in other countries. But a number of those are our friends, and we shouldn't necessarily shut that off in an effort to just have domestic mining or manufacturing, for that matter.

Ms. BLUNT ROCHESTER. And I want to shift to Ms. Brown quickly.

First of all, thank you so much for your testimony, and talking about the history of those kind of fits and starts and hopes for us moving in this direction. You mentioned—when Representative Rush was talking, you talked a little bit, as well, about those communities that historically have been left out. Can you talk about how they will benefit from or contribute to this transition?

Ms. BROWN. Absolutely, and thank you for the question. You know, I think there was a—with the infrastructure bill that was passed and signed into law yesterday, you know, there is a big climate and resiliency component of that bill. And a lot of equity actually was built into the crafting of that bill. And I think we will see some direct benefits in the way of transportation and, you know, making communities more resilient, and also investment in a lot of these communities, because there is money to drive specific investment to attract businesses to these areas.

But I also go back to what I mentioned earlier, in terms of Black and Brown communities. The best economic engine and vehicle to getting to the middle class is a union job. And so, as we are building out the clean energy economy, we have got to make sure that those jobs are our union jobs.

Ms. BLUNT ROCHESTER. All right. Thank you so much.

Thank you, Mr. Chairman, and I yield back.

Mr. TONKO. The gentlelady yields back, and I believe that concludes all of the members from either the—either of the subcommittees.

Oh, I am sorry. Virtually?

OK, virtually, we are joined by Representative Mullin from Oklahoma.

Mr. MULLIN. Yes, sir.

Mr. TONKO. So, Representative, you are recognized for 5 minutes, please.

Mr. MULLIN. Thank you, and I am sorry about jumping in here just real late, but, as you guys can understand, we are running back and forth.

You know, I—my question is pretty easy, I guess, and I have to follow it up with maybe some follow-up questions. But many people, you know, in this committee would like to see all the—you know, all the fossil fuels done away with, as of yesterday. But can someone help explain how natural gas is a necessity, or is necessary as a bridge fuel for the transition?

And I kind of leave that open for whoever wants to grab that question.

Mr. ZINDLER. I will jump in first, and just note that this great decarbonization we have seen of the power sector has been driven by two factors, which is renewables and by cheap natural gas. And the fracking revolution, or whatever you want to call it, the technological advances there have contributed enormously to moving us away from coal. We were 40 percent of our power generation from coal just ten years ago, and now we are down to about 20 percent. And gas has played an enormous role in decarbonizing the power sector. That is where we are today.

The question is where do we go in the future, and whether or not you could continue to have that much gas on the system, and try and get to some kind of decarbonization goal, where you actually address the climate crisis.

Mr. MULLIN. You know, well, it was ten years ago where we were seeing natural gas as the clean energy. And when you start seeing what is happening in Germany, and as they are transitioning, you know, to renewables, you are seeing they also have an increase on their dependency on natural gas to offset it. Because the last time

that I checked, we were really having a hard time figuring out how to store renewables, and be able to meet high-pitch demands when we are facing peak hours.

For instance, in California, the reason why they have rolling blackouts is during peak hours you see that sometimes solar comes offline, especially in the valley. Solar will come offline around 7:00, 8:00 in the summer, when it is still 116 degrees, and people are at home, and there is no way to meet that demand if you don't have on-demand energy—for instance, natural gas or nuclear.

So my question goes back. How do we make that transition without natural gas or nuclear still being part of the portfolio?

Mr. PUGLIARESI. So maybe I could address this. You know, when you look at California, the so-called duck curve, we do not have anything else—and when we use these intermittent fuel sources, or these intermittent technologies, when we—when the sun goes down—and sometimes it is combined with not just with losing the sun, but the wind—you need dense, massive power to bring up the power system as the—as we get into nighttime. And there is no alternative, other than natural gas or some other alternative fossil fuel.

Mr. MULLIN. Right, right.

Mr. PUGLIARESI. And until we have, at scale, these alternatives, this is what we are going to have to do.

Mr. ZINDLER. I want to jump in, because I also feel like there has been a kind of repeated mischaracterization of what has gone on in Germany.

The reality in Germany is that they very quickly decided to close all their nuclear power plants. And that is what has created, in my view, the biggest squeeze on the market there, and the greater reliance on natural gas, and the higher power prices. It has certainly been—they have pushed for renewables for years, but——

Mr. MULLIN. Well, sir——

Mr. ZINDLER. In my view——

Mr. MULLIN. Sir, reclaiming my time here——

Mr. ZINDLER [continue]. The ill-conceived idea about nuclear is——

Mr. MULLIN. To reclaim my time here——

Mr. ZINDLER [continue]. Really what triggered——

Mr. MULLIN. [continue]. When you start looking at what is happening, we are wanting to do away with nuclear, too. So if we are going to—if we are trying to end nuclear, then you are going to have to have natural gas to fill that gap.

And so we are running down the exact same path that Germany has, and we are running down it thinking that we are going to have a different result. And I don't see that happening. I see this being the definition of insanity.

Mr. ZINDLER. Sir, with respect, I agree with you that 20 percent of our power is from nuclear energy, and that is zero carbon, and shutting that down would be madness if you want to address climate change.

Mr. MULLIN. So do you think we should——

Mr. ZINDLER. But if you look at the—could I—just let me finish, please.

Mr. MULLIN. Yes, but let me——

Mr. ZINDLER. The infrastructure bill——

Mr. MULLIN [continue]. We should——

Mr. ZINDLER [continue]. $6 billion to keep those nuclear reactors——

Mr. MULLIN. Sir, hold on a second. Reclaiming my time here, I just want to get back to you. So and—we are—so let's find some common ground here.

You agree with me on nuclear. So do you think we should increase our—decrease our nuclear facilities, then, rather than shutting them down, like a lot of people on this committee is wanting to do?

Mr. ZINDLER. I think, like I said a moment ago, closing the existing nuclear reactors in the United States, if you want to achieve decarbonization, does not make any sense.

Mr. MULLIN. Do you think we should open more?

Mr. ZINDLER. I think it is a technology that should be invested in.

And again, if you look at the infrastructure bill, there are billions of dollars to support advanced nuclear reactors.

Mr. MULLIN. I appreciate it. I yield back my time. Thank you.

Mr. TONKO. The gentleman yields back.

Ms. Brown, I am informed, I believe, that you need to be released because of schedule.

Ms. BROWN. Yes, I have a four-year-old who is not interested in supply chains, but is interested in me picking her up from school. So——

Mr. TONKO. OK. Well, look, we have one more witness, and I am informed that he has no questions of you. So let me just thank you in advance for the insight you have provided, and for the value added you have expressed that the United Steelworkers will bring to the path going forward.

Ms. BROWN. Thank you so much, Chairman.

Mr. TONKO. And thank you for your participation today.

Ms. BROWN. Thank you, and thank you for generously excusing me. Thank you.

Mr. TONKO. OK. All the best to the four-year-old.

Ms. BROWN. Thank you.

Mr. TONKO. Now we will—I believe all of the members of the Subcommittees on Environment and Climate Change and Energy have been recognized. And so now, waived on, we have the gentleman from Pennsylvania, Representative Doyle—Representative Joyce, excuse me.

You are recognized for 5 minutes, please.

Mr. JOYCE. First I want to thank you, Chairman Tonko and Chairman Rush, for allowing me to waive on to this joint subcommittee hearing today, and I want to thank the witnesses for appearing.

As we have heard from many of my colleagues today, America is in the midst of an energy crisis of our own making. Just a year ago our nation was energy independent. And for the first time since 1952, America was a net energy exporter. Now the Biden Administration's policies have allowed American energy and the production of it to falter. And unfortunately, prices are skyrocketing. The President is even resorting to asking OPEC to increase production.

On Monday morning, at my home in Pennsylvania, there was already snow on the ground. And this week the lows are in the twenties. Winter is coming, and my constituents need to heat their homes. To do that, they are paying 274 percent more for natural gas, and over 500 percent more for propane from just a year ago. Americans are now, literally, paying the price for the Biden Administration's failed energy policies.

What Americans truly need is affordable and reliable baseload power. If my colleagues across the aisle are committed to clean energy, then we need to invest in clean diesel fuel, nuclear, and hydroelectric power. We need to invest in innovative technologies that take advantage of the energy reserves that are beneath our feet, so that we can keep our coal and our much-needed natural gas power lines online. We need to find incentives to industry to improve the grid, and develop greater efficiencies, instead of punishing them with taxes and penalties. We need to end the war on liquid fuels, and recognize the progress that is—that has been made and continues to be made on emission standards.

Meanwhile, many of these new proclaimed green energy fixes to our economy are, in fact, harmful to the environment, though—through their use of toxins and hazardous chemicals. For example, the batteries in electric vehicles are notoriously dangerous, and incredibly difficult to dispose of.

Dr. Switzer, my first question is for you. Isn't it true that currently, even when fully discharged, electric vehicle batteries can still have enough electricity remaining in the battery to kill the workers that are handling them?

Dr. SWITZER. Thank you for the question. I would say that, if it is fully discharged, then I think, theoretically, it has no electricity remaining. But I think we have also proven that you can scale and handle these batteries safely to recover the valuable elements contained inside.

Mr. JOYCE. But the potential of a battery to say that it has been fully discharged, and thus have remaining electricity in it, could potentially harm the workers who are dealing with those batteries, correct?

Dr. SWITZER. I think that there will be, of course, the need for safe—for training on how to handle these batteries safely.

Mr. JOYCE. And I think that safety is—definitely needs to be addressed, given the danger in handling, transporting, and recycling electric vehicle batteries.

How will recyclers be paid enough to cover the costs incurred as these batteries become more prolific in the scrap yards?

Dr. SWITZER. I think we are working with more and more partners. But with scale I think we will tilt things one way.

But I also think that the—it is not necessarily—we don't see it as that we have to be paid to recycle these batteries. You know, we see it, actually, quite the opposite, such that we will be returning value to the supply chain because of the value within the battery.

Mr. TONKO. Isn't there a potential of leaching hazardous chemicals from these batteries into our environment?

Dr. SWITZER. I think, you know, there is potential, if done completely the wrong way, but I think what has been shown by us and

by others is that it can actually be done very safely, and at very high yields.

Mr. TONKO. Lastly, there seem to be sufficient markets for electric vehicle batteries. How and when will these markets continue to develop?

Dr. SWITZER. I think the markets—I think what we will see is, as I mentioned before, is that these end-of-life electric vehicle batteries won't be viewed as liabilities, but rather as assets. And, you know, even as Redwood Materials—we will, essentially, be competing with others, because they will see value in these, and they will be—we will, essentially, be competing to return value to the supply chain, to get access to these batteries to recycle them.

Mr. JOYCE. Currently, I see the value in the resources that are under the feet of my constituents. I see the importance of being able to maintain those energy sources to provide efficient and cost-effective ways for Americans to heat in this upcoming winter.

First of all, thank you for your summary answers. And I secondly want to thank Chairman Rush and Chairman Tonko for allowing me to waive on to this important hearing. Thank you, and I yield back.

Mr. TONKO. You are most welcome, Representative Joyce. And that concludes, I believe, the list of colleagues who wanted to question our witnesses.

Let me thank our witness panel. You have been great in providing insight and answering questions that will prove useful as we move forward with policy development. So I thank you kindly for all of that commitment, and your patience.

I remind members that, pursuant to committee rules, they have ten business days by which to submit additional questions for the record to be answered by our witnesses. And I ask only that our witnesses respond promptly to any such questions that you may receive.

With that, before we adjourn, I have a request for unanimous consent to enter the following documents into the record:a letter from the MP Materials Corporation;we have a letter from the United States Nuclear Industry Council;we have a letter from the National Mining Association;we have a report from the Digital Climate Alliance;we have a report from the Center for American Progress entitled, "Creating a Domestic U.S. Supply Chain for Clean Energy Technology"; we have a report from the Center for Strategic and International Studies entitled, "Reshore, Reroute, and Rebalance: A U.S. Strategy for Clean Energy Supply Chains."

I also have a request for a report from CSIS and BloombergNEF entitled, "Industrial Policy, Trade, and Clean Energy Supply Claims"; we have a letter from House Energy and Commerce Republican members to Chairman Pallone; we have an article from The Wall Street Journal entitled, "Germany's Economy, Once Europe's Engine, is Holding it Back"; we have a backgrounder from the Heritage Foundation, "The Need to Examine the Life Cycles of All Energy Sources: A Closer Look at Renewable Energy Disposal"; we also include an article from Greenwire entitled, "Low Pay, Abusive Conditions Rife at Congolese Cobalt Mines"; we have a report from the Manhattan Institute entitled, "Mines, Minerals, and Green Energy: A Reality Check."

I have a letter from Energy and Commerce Republican members to Secretary of Energy Jennifer Granholm; we have a letter from Secretary Granholm to Ranking Member McMorris Rodgers; and finally, an article from Yahoo Finance entitled, "UK Power Prices Soar Above 2,000 on Low Winds."

Without objection, so ordered.

[The information appears at the conclusion of the hearing.]

Mr. TONKO. And with that, that brings to a conclusion our subcommittee's meeting and hearing. And with that, we adjourn.

[Whereupon, at 2:52 p.m., the subcommittees were adjourned.]

November 15, 2021

The Honorable Frank Pallone, Jr.
Chairman
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Cathy McMorris Rodgers
Ranking Member
Committee on Energy and Commerce
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The Honorable Paul Tonko
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The Honorable David McKinley
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The Honorable Bobby Rush
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The Honorable Fred Upton
Ranking Member
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RE: Hearing on "Securing America's Future: Supply Chain Solutions for a Clean Energy Economy"

Dear Chairmen and Ranking Members:

As Chairman and Chief Executive Officer of MP Materials Corp., I applaud the Committee for holding a hearing on securing America's supply chains in support of a clean energy economy. This is a topic of paramount national importance and one that aligns with the fundamental goals of our company.

In recent years significant national security and economic competitiveness risks have emerged due to the erosion of the U.S. rare earth element (REE) supply chain. The United States currently lacks domestic capacity to produce both separated REEs and the downstream NdFeB (neodymium-iron-boron) permanent magnets which are used in a wide variety of clean technology, defense, and consumer product applications. Instead, the United States and our allies depend on imports to fulfill practically all rare earth magnet requirements. These imports primarily rely on China's dominant capacity to both separate rare earth products and manufacture NdFeB magnets. Moreover, China has recently begun a process to exercise even

more centralized control over its permanent magnet supply chain by further consolidating its domestic REE materials industry.[1]

The establishment of large-scale, commercially viable capabilities across the full U.S. rare earth supply chain is the most effective and most efficient way to counteract this dynamic. MP Materials is leading this effort through our strategy to develop and operate a wholly domestic, vertically integrated REE value chain in America. Supportive engagement from the U.S. Government is important in helping the private sector establish domestic capacity at commercially meaningful levels across the entire REE supply chain, including production of materials, metals, alloys, and magnets, thereby ensuring a sustainable supply base capable of serving commercial and defense needs.

Background

Headquartered in Las Vegas, Nevada, MP Materials is the largest rare earth materials producer in the Western Hemisphere and the largest such producer outside of China. The company owns and operates the nation's only significant rare earth element mine and processing site at Mountain Pass, California. The Company's mission is to restore the *full* rare earth supply chain to the United States by implementing a three-stage strategy to produce (1) REE concentrate, (2) separated REEs, and (3) NdFeB magnets. MP Materials is publicly listed on the New York Stock Exchange under the ticker symbol "MP."

MP Materials acquired Mountain Pass in July 2017, after severe operational and financial challenges forced the site's prior owner into bankruptcy. At the time, the site was in a state of care and maintenance with just eight employees. In four short years, MP Materials has scaled production at Mountain Pass dramatically, and we now have over 365 employees.

REEs have a number of key applications, which include strong permanent magnets made from REE alloys. A typical NdFeB magnet contains about one-third neodymium (Nd) or a combination of Nd and praseodymium (Pr). As such, NdFeB magnets are also commonly referred to as NdPr magnets. These magnets are considered the most high-performing, compact, and lightweight permanent magnet commercially available. They are essential components in green technology products, including motors of electric and hybrid vehicles and wind turbines. Like semiconductors, which became linked to virtually every aspect of modern life as computers and software proliferated, rare earth magnets are fundamental building blocks, which will increase in importance as the global economy electrifies and decarbonizes.

U.S. production of separated REEs has been constrained and domestic production of sintered NdFeB magnets is virtually non-existent. The last major vertically integrated U.S. magnet producer ceased operations in 2003 and relocated to China.[2] Today, China produces

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[1] See https://www.bloomberg.com/news/articles/2021-09-24/china-s-rare-earth-minersannounce-plan-to-restructure-assets.

[2] See Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based

approximately 80 percent of the world's separated REEs and approximately 90 percent of NdFeB magnets.

MP Materials is taking action to develop large-scale capacity across the full rare earth supply chain in the United States. In 2020, production of rare earth oxides ("REO") contained in concentrate at Mountain Pass reached an all-time high, bringing the United States to more than 15 percent of global production from 0 percent in 2017.[3] MP Materials is also addressing the lack of separation facilities in the United States by investing more than $220 million to restore REE separations capability to Mountain Pass. This work is supported by the Department of Defense ("DoD") through the Defense Production Act and Industrial Base Analysis and Sustainment programs. The Company plans to begin producing separated rare earth products at Mountain Pass in the second half of 2022.

Informed by our experience over the past four years, MP Materials holds a deep conviction that private entities in the United States can challenge Chinese dominance and achieve commercial success across the rare earth supply chain, including NdFeB metal and magnet production. Against the backdrop of an industrial renaissance towards electrification and decarbonization, MP Materials believes that ensuring a sustainable, domestic supply base of all REEs necessary for magnet production is essential to the defense, industrial security, and global economic competitiveness of the United States.

MP Materials' Three-Stage Strategy

To help lead the revitalization of the U.S. REE industry, MP Materials is implementing a three-stage strategy as follows:

- **Stage I: Production of REE Concentrate *(completed)***: extracting ore from Mountain Pass and purifying and concentrating the ore to create a mixed rare earth concentrate.

- Stage II: Production of Separated REEs *(2022)*: applying a complex chemical process to the mixed rare earth concentrate in order to purify, recover, separate, and precipitate individual rare earth elements.

- Stage III: Production of NdPr Metal, Alloy and Magnets *(ASAP)*: further processing separated REEs into products such as NdPr metal, alloys and magnets.

Stage I: Production of REE Concentrate

In Stage I, bastnaesite ore is recovered from an open-pit surface mine. Through a process of crushing, milling, conditioning, and flotation, REEs are separated from waste to produce a mixed rare earth concentrate containing approximately 60 percent REO.

Growth, 100-Day-Reviews under Executive Order 14017, June 2021 ("100-Day Supply Chain Report") at 174.

[3] See USGS, Rare Earths 2021, https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-rare-earths.pdf.

MP Materials has already been successful in implementing its Stage I strategy, and due to the tremendous geological advantages of the Mountain Pass ore body, which averages seven percent REE content (versus 0.1 to 4 percent for most global deposits in operation, including the major Chinese producers),[4] we believe that MP Materials enjoys a leading cost position.

The Company's efforts to optimize Stage I production of rare earth concentrate have yielded a highly profitable business generating significant free cash flow that the Company is now reinvesting to expand its capabilities in downstream production.

In addition to having a low-cost position, the Company believes that Mountain Pass is the world's cleanest, most environmentally sustainable REE facility.

For example:

- **Clean ore body**: At a geological level, the bastnaesite ore at Mountain Pass has low levels of thorium and uranium relative to other rare earth deposit types around the world. The concentrate produced at Mountain Pass has no radioactive by-product and contains only trace levels of thorium and uranium.

- **Dry tailings**: To substantially eliminate seepage risk, Mountain Pass employs a drystacked tailings process. Dry tailings produced at Mountain Pass are retired in lined impoundments, meaning we believe the material is returned to ground with nearly as little risk to the environment as the hard rock from which it is extracted. This facility is the only one of its kind in the global rare earth industry.[5]

- **Closed loop, zero discharge facility**: The Company maintains and operates a well field for potable and process water, which pumps directly to Mountain Pass and has no connection to public water sources. To conserve water and further minimize the Company's environmental footprint, approximately 95 percent of the water used is recycled – more than one billion liters per year. Mountain Pass is a zero-discharge facility with no process water disposed offsite or to the ground.

- **Environmental compliance**: Mountain Pass is fully permitted for rare earth extraction, separation, and waste management. The Company complies with all Federal and California environmental regulations.

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[4] As of July 1, 2020, SRK, an independent consulting firm the Company has retained to assess its reserves, estimates probable reserves of 1.47 million short tons of REO contained in 20.8 million short tons of ore, with an average ore grade of 7.04 percent.

[5] It is reported just 13 dry-stacked tailings facilities of any mineral resource have been placed into operation in the past decade worldwide, and only three to six percent of global tailings facilities in operation today are dry stacked, with MP Materials operating the only one of its kind in the rare earth industry. See https://www.nature.com/articles/s41598-021-84897-0.

Today, the rare earth concentrate that MP Materials produces is exported to a distributor, which, in turn, sells that product to multiple customers in China who process the concentrate into separated rare earth products. There is no domestic alternative today, as no viable REE separations facilities exist in the United States. MP Materials' Stage II strategy seeks to address this situation.

Stage II: Stage II: Production of Separated REEs

In this stage, the Company's concentrate product will be separated into NdPr oxide, cerium and lanthanum carbonate, and a heavy rare earth concentrate (SEG+). The Company has been retrofitting the existing processing facility at Mountain Pass to make separated rare earth oxides more reliably, which will materially increase the recovery of NdPr from concentrate and dramatically lower the cost of production, all with an expected smaller environmental footprint.

Although light rare earths such as neodymium and praseodymium are the most abundant REEs in NdFeB magnets, small volumes of heavy rare earth elements (HREEs), namely terbium and dysprosium, are often introduced into NdFeB alloy mixtures to enable high operating temperatures. Currently, there is virtually no capacity to produce separated HREEs outside of China.

Over the last 12 months, in part with funding from the DoD Industrial Base Analysis and Sustainment program, the Company has been conducting research and development and significant piloting to analyze the potential to restore the capacity to produce separated HREEs at Mountain Pass.

Stage III: Production of NdPr Metal, Alloy, and Magnets

In Stage III, MP Materials will use REOs that are purified, recovered, and separated in Stage II to manufacture NdPr metal, alloy and permanent magnets in the United States. We expect to make an announcement on the location of our initial magnetics facility by the end of 2021. This first facility will be modest relative to the size of the resource at Mountain Pass but will have the capacity to grow. Furthermore, we are building capabilities to accept substantial volumes of recycled magnet content into our large-scale refining facilities. This ability to accept both virgin materials and recycled content into the same manufacturing stream will allow us to continue to expand capacity to meet growing demand over time while further reducing the system's carbon footprint.

Recommended Government Actions

To create systemic resiliency and challenge Chinese rare earth dominance, U.S. industry must establish commercially viable capabilities across the full rare earth supply chain, and U.S. policymakers, through a whole-of-government approach, should support these efforts by addressing systemic market inequities and leveling the global playing field.

Interestingly, Congressional policies have routinely supported the scaling of downstream consumer products and industries, including electric vehicles and wind turbines, but they have not equally incentivized the production of requisite materials upstream. Supporting end-use downstream products while ignoring or underinvesting in the necessary upstream critical materials supply chain simply limits the maximum economic and environmental benefits to U.S. workers and the economy.

We believe that in addition to the Department of Energy and Department of Defense's continued support for scaled rare earth separations projects, and related research and development, the U.S. Government should advance demand-driven legislation that supports domestically sourced and produced rare earth products. A production tax credit for domestic magnet production, for example, will benefit the entirety of the domestic REE supply chain by pulling the upstream and midstream components toward the ultimate goal of manufacturing NdFeB magnets in the United States. In this regard, the bipartisan Rare Earth Magnet Manufacturing Production Tax Credit Act (H.R. 5033) is a good first step to accelerate domestic private sector investments in REE materials and NdFeB magnet production.

Under this bill, magnets manufactured in the United States from rare earth materials produced, Recycled, or reclaimed wholly in the United States will be eligible for a $30/kg production tax credit. A $20/kg production tax credit would be available for other magnets that are manufactured in the United States. The credit would not be available for a magnet manufactured with any component rare earth material that is produced in a non-allied foreign nation, such as China, Iran, North Korea, and Russia.[6] The tax credit could significantly bolster domestic supply chains by incentivizing the use of domestically produced REE and set the stage for a phased shift of supply away from imports.

Separately, as detailed in the Administration's 100-Day Supply Chain Report, the U.S. Government should work in partnership with the private sector and other stakeholders to develop new standards for REEs that will help environmental and social factors be appropriately valued in the marketplace. "A recognized sustainability standard, potentially backed by legislation, and coordinated with trading partners, would encourage private sector investment in sustainable sources and increase supply chain resilience."[7] MP Materials agrees that the long-term aim should be to promulgate regulations that would support the use of "sustainably produced" REE from domestic and foreign sources.[8] Sustainability standards will ensure that global supply chains do not continue to favor jurisdictions with lax environmental, labor, and governance regimes.

Our experience of the past four years has bolstered our confidence in the ability of MP Materials and other U.S. private sector actors to achieve sustained commercial viability and challenge

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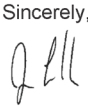
[6] https://www.congress.gov/117/bills/hr5033/BILLS-117hr5033ih.pdf.
[7] 100-Day Supply Chain Report at 194.
[8] See id at 194-195.

Chinese dominance in the REE supply chain. Through its efforts to cultivate domestic capabilities, the United States Government can help industry truly turn the corner and establish a secure, domestic supply chain to support clean energy development, defense interests, and global competitiveness.

Thank you for your consideration of these comments.

Sincerely,



James Litinsky
Chairman & Chief Executive Officer
MP Materials Corp.

United States Nuclear Industry Council
1317 F Street NW Washington, DC 20004

To:

The Honorable Paul Tonko
Chairman
House Committee on Energy & Commerce
Subcommittee on Environment & Climate Change
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable David B. McKinley
Ranking Member
House Committee on Energy & Commerce
Subcommittee on Environment & Climate Change
2322 Rayburn House Office Building
Washington, DC 20515

The Honorable Bobby Rush
Chairman
House Committee on Energy & Commerce
Subcommittee on Energy
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Fred Upton
Ranking Member
House Committee on Energy & Commerce
Subcommittee on Energy
2322 Rayburn House Office Building
Washington, DC 20515

Dear Chairmen Tonko, Rush, and Ranking Members McKinley and Upton:

I write on behalf of the United States Nuclear Industry Council (USNIC) regarding your subcommittee's upcoming hearing regarding the supply chain needs for a clean energy future. The adequacy of a robust supply chain is a central element confronting the United States', and indeed the world's, ability to meet the transition from our current means of energy production to that of a lower carbon future.

Accordingly, your subcommittees are to be commended for holding the upcoming hearing this week on "Securing America's Future: Supply Chain Solutions for a Clean Energy Economy." I would be remiss, however, if I did not note the absence of a focus on the supply chain issues attendant to the most promising source of zero carbon electricity generation technology—advanced nuclear technology.

Because of the significant contribution that advanced nuclear can make to the future of the carbon reduction goals, and recognized to be crucial to meeting any realistically significant carbon reduction in the generation of electricity, I urge that future hearings focusing on this important area will be inclusive and will cover the important issues challenging today's nuclear energy supply chain. As you consider the substance of these future hearings, serious consideration should be given to currently available data on the science, economics, and national security data that is attendant to our nuclear future, and the crucial role that supply chain issues form the foundation for the success, or failure, of our future.

As we are all aware, businesses must constantly evaluate and limit risk as they determine where to allocate capital. No sensible businessperson would allocate capital for major investment in a venture absent the ability to identify a source of items needed to complete production. Imagine investing in the auto industry with no identifiable or reliable source of tires, headlights, lubricants, etc. Yet the nuclear industry, especially the advanced nuclear industry, face a roughly analogous situation.

Consider the most immediate and perhaps most glaring issue. Highly Enriched Low Assay Uranium (HALEU) is the fuel that will be needed to operate many of the most innovative and beneficial technologies that are being developed. Yet, the United States today has a wholly inadequate ability to produce this fuel. Shockingly, we remain captive to Russia for the fuel that we will rely on to power our advanced nuclear fleet. Yet this is far from the only supply chain issue our country faces.

From 1969-1990 over 40% of the entire world's nuclear fleet relied on the United States for materials needed to supply operations. Between 1991 to 2017 that 40% was eroded by China and Russia, to the point that today the US supplies only 8% of this market need. This alarming statistic alone deserves the attention of Congress, with a close examination not only of the cause of this erosion, but more importantly the implications these negative supply chain matters have upon America's future on the nuclear energy front.

It is worth also noting that jobs in the nuclear sector pay exceptionally well. Median salaries for permanent nuclear energy jobs are 20% higher than those for coal and natural gas, and a full 65% higher than for solar and wind. Billions of dollars in economic activity will follow deployment of advanced nuclear facilities. Jobs, tax revenues, and increased standards of living will flow with advanced nuclear development. Failing to maintain the economic value attendant to the nuclear energy sector would in itself be irresponsible. Failing to open even broader opportunities associated with advanced nuclear would be tragic.

Sadly, however, over the last 25 years there have been only two new nuclear plants connected to the U.S. grid and today there is only one active new nuclear plant build project under construction and that project is nearing completion. As a result, the U.S. commercial nuclear supply chain has atrophied and will require special attention if it is to support the deployment of a new generation of advanced reactors that are required to meet this Nation's decarbonization goals targeted for the electricity sector.

In sum, if the United States expects to be a relevant player in the advanced nuclear future, we must ensure that the private sector is convinced that the investment of capital is rational, and that there is unwavering support from the federal government to do its part to ensure the success of America's otherwise unmatched ability to meet the challenges faced in the advancement of clean and safe nuclear energy.

We cannot recapture America's once dominant position as the world leader in all things nuclear without addressing where we stand today and what is needed to regain preeminence. For this we must have the support of the federal government. Accordingly, USNIC looks forward to doing anything we can to help parse out the various challenges and opportunities to ensure that America rises to reclaim our role as the leader in a clean nuclear energy future.

Sincerely,

Bud

Bud Albright
President & CEO
U.S. Nuclear Industry Council (USNIC)
Mobile: 703-408-9024
Bud.albright@usnic.org

RICH NOLAN
President & CEO

November 16, 2021

The Honorable Bobby Rush
Chairman
Subcommittee on Energy
2123 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Fred Upton
Ranking Member
Subcommittee on Energy
2123 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Paul Tonko
Chairman
Subcommittee on Environment and Climate Change
2123 Rayburn House Office Building
Washington, D.C. 20515

The Honorable David McKinley
Ranking Member
Subcommittee on Environment and Climate Change
2123 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairmen Rush and Tonko, Ranking Members Upton and McKinley,

The National Mining Association (NMA) is the national trade association representing the producers of most of the nation's hardrock metals, coal, industrial and agricultural minerals; and manufacturers of mining and mineral processing machinery, equipment and supplies.

On behalf of our hardrock members, the NMA appreciates the opportunity to submit this letter for this morning's hearing titled, "Securing America's Future: Supply Chain Solutions for a Clean Energy Economy." NMA members produce hardrock minerals and metals on private, state and federal lands throughout the United States. As the front end of the supply chain for manufacturing, energy and infrastructure, healthcare, national security, and many other sectors, mining is an essential industry that stands able to address the new and increasing demands for raw materials the nation needs while adhering to the highest safety and environmental standards in the world.

Ever-increasing Demand for Minerals

In 2020, even as COVID-19 impacted the landscape of our nation and caused so much harm in our communities, the mining industry employed an estimated 1.2 million jobs in all 50 states. Annual salaries for these workers – often in rural areas – averaged more than $81,000, well above the national average. Further, from 2019 – the most recent numbers available – domestic mining activity generated an estimated $18 billion in federal, state and local taxes that supported direct, indirect and induced taxes of $41 billion.

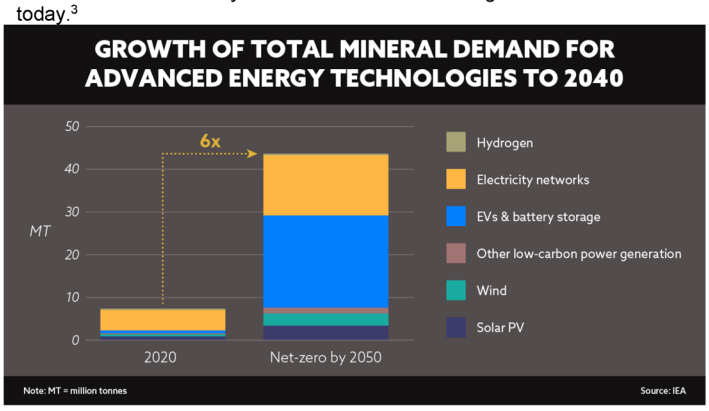
The mining industry provides the metals and minerals necessary for economic recovery and the growth, innovation and advancements required to meet the needs of tomorrow.

The Biden administration has acknowledged the importance of the domestic mining industry to the U.S. economy through the January "Made in America" Executive Order's acknowledgment that Made in America means Mined in America, and the American Supply Chains Executive Order expressing the need to secure our mineral supply chains. This can only continue to be accomplished by making careful policy decisions today.

In 2017, the World Bank projected demand for targeted minerals would grow more than 1,000 percent due to the global focus on new energy technologies.[1] The World Bank's 2020 report predicted an astounding 500 percent increase in broad categories of mineral demand to feed the needs of emerging technologies.[2]

More recent estimates from the International Energy Agency (IEA) and others show those estimates may have been far too conservative and that demand for some minerals could grow by more than 40 times by 2040. According to IEA:

- Lithium demand is anticipated to grow by more than 40 times by 2040, followed by graphite, cobalt and nickel at around 20-25 times;
- Copper demand for grid infrastructure and electrification more than doubles by 2040;
- Demand for cobalt is expected to be anywhere from 6 to 30 times higher than today's levels; and
- Rare earth elements may see three to seven times higher demand in 2040 than today.[3]



[1] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/207371500386458722/the-growing-role-of-minerals-and-metals-for-a-low-carbon-future
[2] https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf
[3] https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

The U.S. can lead the world in electric vehicle (EV) production and technology but to do so we must reshore critical industries and develop of a world-class mineral supply chain. By supporting American mining of metals like copper, silver, lithium and nickel, and investing in the domestic plants that make batteries for EVs, the U.S. can meet global demands for EV manufacturing and infrastructure. Our made-in-America EV future can also be a mined-in-America future with U.S. mining ready to meet much of this need while continuing to provide high-paying jobs and maintaining strong environmental protections.

- An EV made today typically uses on average 183 pounds of copper and a mile of copper wiring. By 2030 the EV sector will require 250% more copper compared to current demands.[4]
- EVs can use nearly twice the amount of silver compared to gasoline powered cars.[5]
- Global demand for nickel for EVs and other uses is expected to increase 10 times in only the next five years;[6]

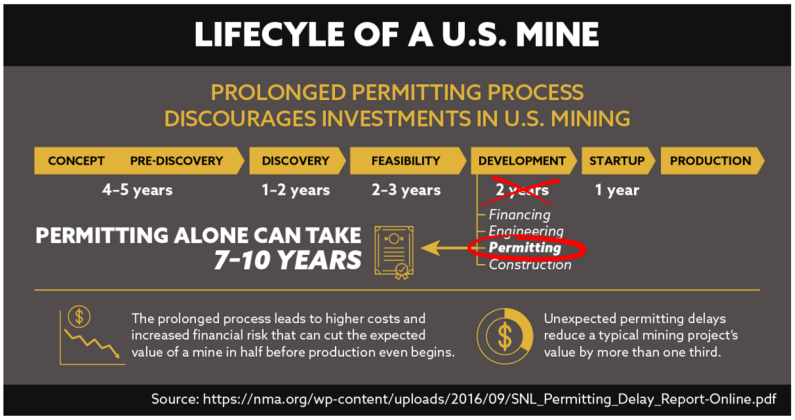
Just as the world began to awaken to the impending exponential growth in demand, the pandemic unleashed a massive disruption of supply chains putting a renewed focus on mineral supply chain risks. With over $6 trillion worth of mineral resources here in the United States, a highly trained and highly compensated workforce, and world-class environmental and safety standards, the U.S. mining industry can help the nation meet ever-increasing demand for minerals for electrification, infrastructure and manufacturing needs. And there is significant public support for using our own resources rather than increasing reliance on foreign sources. According to recent polling conducted by Morning Consult, 84 percent of Americans believe any "Made in America" agenda, such as the administration's effort to win the electric vehicle revolution, should use domestically sourced minerals.

However, there is real room for improvement. To improve supply chain security, we must also have a robust domestic mineral supply chain. That includes more smelting, processing and refining capabilities in the U.S. necessary to claw back these essential processes from geopolitical adversaries like China, which controls more than 80 percent of global rare earth element production and significant mineral processing capabilities.

Nearly two decades ago, the U.S. attracted almost 20 percent of the world's total mining investment. Unfortunately, in the time since, there has been a sharp decline in U.S. exploration investment. This is not due to lack of resources, but rather a lack of confidence in the U.S. as a viable mining jurisdiction in which to invest hundreds of millions of dollars in upfront costs due to duplicative, inefficient and costly permitting timeframes, making the

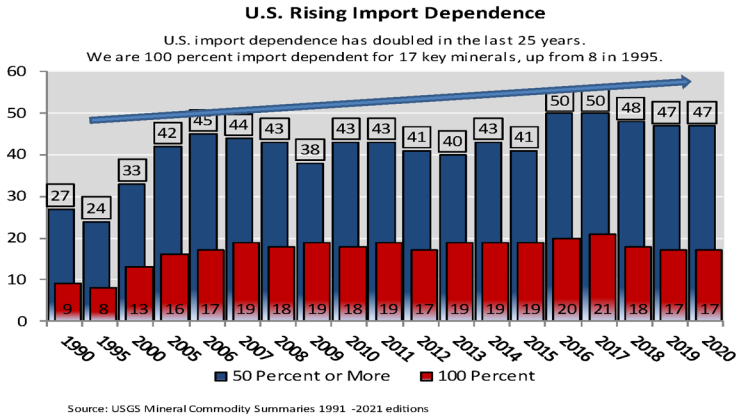
[4] http://www.visualcapitalist.com/the-looming-copper-supply-crunch
[5] www.silverinstitute.org/silver-consumption-global-automotive-sector-approach-90-million-ounces-2025/
[6] https://www.ey.com/en_us/mining-metals/why -mineral-supply-may-be-an-e-mobility-roadblock

U.S. more dependent on other countries for metals. It currently takes seven to 10 years – or longer – to permit a mine in the U.S. In Canada and Australia, which have environmental standards comparable to those in the U.S., it takes two to three years to complete the same process.



The U.S. is increasingly vulnerable to supply chain disruptions and retaliation from geopolitical adversaries due to our ever-increasing reliance on imports for these essential resources. Less than half of the mineral needs of U.S. manufacturing are met by domestically produced minerals, which leaves our economy and national security at a strategic disadvantage. The U.S. Geological Survey's annual commodity summary reports that we now find ourselves entirely import dependent for 17 key mineral resources and more than 50 percent import dependent for an additional 29. Of the 35 mineral commodities listed as essential for U.S. economic and national security, China is the top producer or top supplier for 23 of them.[7]

[7] https://www.usgs.gov/centers/nmic/mineral-commodity-summaries



Source: USGS Mineral Commodity Summaries 1991 -2021 editions

A secure supply chain of minerals and rare earth elements is vital to key sectors of the U.S. economy. The demand for these resources will only continue to grow and it is not a question of if minerals will be mined to meet every increasing demand, but rather where they will be mined. To further support new domestic production, we need a robust domestic supply chain that includes minerals and metals sourced, refined, processed and smelted within our borders. These types of actions will attract investment, reshore essential supply chains and build the materials industrial base needed to underpin new technologies and innovation. The U.S. must remain competitive with a strong, skilled and adaptive workforce to continue to attract necessary investment to meet the future needs of the modern mining industry.

I believe there is an opportunity to work in a bipartisan manner to prioritize minerals-related policies that will enable the development of the metals and minerals that will allow our nation to achieve greater innovation, supply chain security and economic growth, while protecting the environment. Thank you for holding this hearing and allowing the NMA to submit these comments.

Sincerely,

Rich Nolan

FRANK PALLONE, JR., NEW JERSEY
CHAIRMAN

CATHY McMORRIS RODGERS, WASHINGTON
RANKING MEMBER

ONE HUNDRED SEVENTEENTH CONGRESS

Congress of the United States
House of Representatives
COMMITTEE ON ENERGY AND COMMERCE
2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6115
Majority (202) 225-2927
Minority (202) 225-3641

November 12, 2021

The Honorable Frank Pallone, Jr.
Chairman
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Pallone:

We write to urge you to hold hearings to address the energy crisis and preparations for the upcoming winter. We have serious concerns about rapidly rising energy prices and the negative impact these price increases are having on the U.S. economy, inflation, and household bills.

As you know, energy prices have reached seven-year highs under President Biden's watch. The price of gasoline has nearly doubled since last year. High prices for other energy commodities, such as natural gas and propane, are inflicting serious harm to our economy, while supply-chain interruptions and shortages threaten to cause fuel outages in some regions of the country. Compared with last winter's heating costs, the Department of Energy (DOE) forecasts U.S. households will spend 54 percent more for propane, 43 percent more for heating oil, 30 percent more for natural gas, and 6 percent more for electric heating. U.S. households will spend even more if the weather is colder than expected.[1]

Millions of Americans depend on reliable and affordable supplies of fossil-based fuels for home heating, electricity, transportation, manufacturing, and agriculture. Energy price increases are also passed along in many goods and services, stretching family and household budgets, and exacerbating energy poverty.

[1]U.S. Energy Information Administration. (October 13, 2021). *EIA forecasts higher U.S. heating bills this winter*. [Press release]. https://www.eia.gov/pressroom/releases/press488.php

In October, we wrote to DOE Secretary Granholm to assist with an assessment of the emerging impacts of higher energy prices. We asked the Secretary to describe what actions DOE is taking to address energy prices and supply shortages ahead of the upcoming winter, and what Federal regulations may be contributing to energy price increases. We are concerned that DOE is failing to meet its statutory obligations to protect America's energy security. Seemingly divorced from reality, proposals by the Administration and Democrats in Congress to raise energy prices further through additional regulations and a new natural gas tax are also of great concern.

While we understand that global supply chain disruptions and demand shocks related to the COVID-19 pandemic have influenced domestic prices, the Administration's anti-fossil fuel agenda is significantly contributing to this energy crisis. On his first day in office, President Biden revoked the permit for the Keystone XL pipeline and imposed a moratorium on fossil energy development on Federal lands and waters. In response to high energy prices, rather than encourage domestic production, the Administration has called on the Organization of the Petroleum Exporting Countries (OPEC) and Russia to increase oil supplies.

The Secretary of Energy has also made surprising statements about responding to the self-inflicted price spikes by releasing emergency oil reserves from the Strategic Petroleum Reserve or imposing a ban on oil exports. Recently, the Secretary made concerning statements regarding OPEC's influence on global markets and the ability of the U.S. to increase production and drive down prices.[2] Rather than accepting responsibility for unacceptably high energy prices, the Secretary appears to shift blame to OPEC, Russia, and U.S. oil producers for not increasing supplies quickly enough.[3]

This Committee must conduct oversight over DOE's handling of the energy crisis to understand better its actions and what steps Congress may need to take ahead of the upcoming winter. We should also investigate how regulations may be causing or contributing to energy price increases and whether the Administration's potential shutdown of another major U.S. pipeline — Enbridge's Line 5 pipeline — will result in adverse economic impacts and fuel shortages across the Midwest.[4]

The Administration's handling of the energy crisis deserves serious and diligent oversight, and the Committee should plan hearings as soon as possible. Thank you for your consideration.

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[2]Meet the Press. (October 31, 2021). https://m.youtube.com/watch?t=775&v=B71cBRPgt9k&feature=youtu.be
[3]CNN. (November 7, 2021.) *Granholm: I certainly hope gas prices won't reach $4 per gallon. https://www.cnn.com/videos/politics/2021/11/07/sotu-granholm-gas.cnn*
[4] Politico. (November 4, 2021). *Crude awakening on Line 5. https://www.politico.com/newsletters/ottawa-playbook/2021/11/04/line-5-crude-awakening-and-the-merits-of-diet-poutine-494974*

Sincerely,

Cathy McMorris Rodgers
Republican Leader
Committee on Energy and Commerce

Fred Upton
Republican Leader
Subcommittee on Energy

David B. McKinley
Republican Leader
Subcommittee on Environment and
Climate Change

Michael C. Burgess, M.D.
Member of Congress

Steve Scalise
Member of Congress

Robert E. Latta
Member of Congress

Brett Guthrie
Member of Congress

Adam Kinzinger
Member of Congress

H. Morgan Griffith
Member of Congress

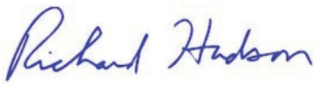
Gus M. Bilirakis
Member of Congress

Bill Johnson
Member of Congress

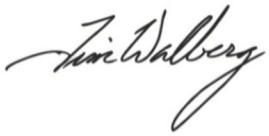
Billy Long
Member of Congress

Larry Bucshon, M.D.
Member of Congress

Markwayne Mullin
Member of Congress



Richard Hudson
Member of Congress



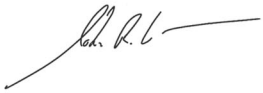
Tim Walberg
Member of Congress

Earl L. "Buddy" Carter
Member of Congress

Jeff Duncan
Member of Congress

Gary J. Palmer
Member of Congress

Neal P. Dunn, M.D.
Member of Congress



John Curtis
Member of Congress

Debbie Lesko
Member of Congress

Greg Pence
Member of Congress

Dan Crenshaw
Member of Congress

John Joyce, M.D.
Member of Congress

Kelly Armstrong
Member of Congress

https://www.wsj.com/articles/germany-economy-lagging-behind-europe-supply-chain-11636383954

Germany's Economy, Once Europe's Engine, Is Holding It Back

Export-oriented businesses fare poorly in post-pandemic world of broken supply chains and rising energy prices; calls for a reboot

By Tom Fairless
Nov. 8, 2021 10:13 am ET

BAD MARIENBERG, Germany—Germany's export-oriented economy used to be a reliable engine for pulling Europe out of slumps. Now, as the continent emerges from a pandemic torpor, Germany is lagging behind.

German manufacturers are struggling to produce cars and factory equipment because of parts and labor shortages. They face surging energy prices that are making sky-high electricity bills even higher. And they must invest hundreds of billions of dollars over coming years to meet new clean-energy standards.

The era of easy foreign trade and rapid globalization has given way to geopolitical tensions, transport bottlenecks and pressure to manufacture locally. Chinese businesses, Germany's biggest customers, are turning into competitors. Demand for German luxury cars hangs in the balance as the world shifts toward electric vehicles.

German industrial output in August was about 9% below its 2015 level, compared with a 2% increase for the eurozone as a whole, according to the European Union's statistics agency. In Italy, whose manufacturers are closely tied with Germany's, industrial output rose about 5% over the six-year period.

The International Monetary Fund recently lowered its forecast for German economic growth in 2021 to 3.1%, from 3.6%. It expects Germany's economy to recover roughly in line with France and the U.K. through 2022, then fall behind starting in 2023.

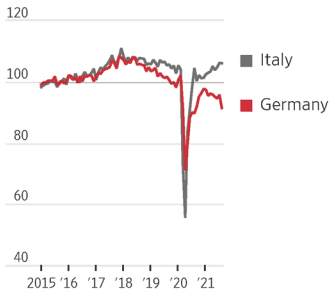
The malaise is fueling a debate among business and political leaders over whether the German economy needs a reboot and what it should look like. The three parties negotiating a new coalition government following September's election want to increase public investments, raise wages and streamline planning procedures, which could boost domestic sources of growth and make companies less dependent on foreign demand.

If implemented, the plans would represent the most comprehensive economic overhaul in years. Some economists think they also carry significant risks.

Economic Stall

German industrial production has stalled amid geopolitical tensions, transport bottlenecks and a shift to green energy

Industrial production index, manufacturing



Note: 2015=100
Source: Organization for Economic Cooperation and Development

The weakness in Germany's economy predates the Covid-19 pandemic. German industrial output and exports began stagnating in 2017, posing a problem for an economy where some 30% of jobs and output are tied to overseas demand, roughly four times the share in the U.S.

The last time growth in Germany lagged markedly behind that of European neighbors was in the late 1990s and early 2000s, before a series of unpopular economic overhauls revived the country's competitiveness. For a few years, Germany was the world's biggest exporter of goods.

Hans Eichel, a former German finance minister who presided over some of those reforms in 2003, said that today "the external environment is more difficult than 20 years ago. Even China is looking more and more toward internal demand."

At Wilo SE, a pump manufacturer in northwest Germany, sales rose by more than 50% in the eight years through 2017, to €1.4 billion, or about $1.6 billion, driven mainly by new markets such as China. Since then, its sales, most of which come from outside Germany, have been roughly flat.

To guard against trade disruptions and protectionism, Chief Executive Oliver Hermes said, the company is shifting production and executives closer to its customers. It is establishing a second headquarters in Beijing and plans a third in the U.S., and will add production sites in China and India.

The shift toward more localized production could mean "less export from Germany," Mr. Hermes said, meaning fewer jobs in its home country. The company recently said it would close a factory in Eastern Germany, cutting or shifting 120 jobs.

Like other German auto suppliers, Mann+Hummel, a manufacturer of air-filtration systems based in southern Germany, faces a tricky transition as gas and diesel engines are phased out. Its sales declined about 9% last year as global car sales slowed during the pandemic.

Sales have declined at Mann+Hummel, which supplies auto makers with filtration systems.

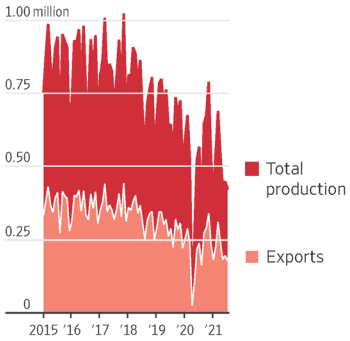
PHOTO: MANN+HUMMEL

"Supply-chain challenges and trade disputes have put stress on our model," said Chief Executive Kurk Wilks. Raw material prices are rising, China's economy isn't growing as fast, and there are labor shortages, especially in the U.S., he said. "Beyond price increases, it's the shortages of materials, certain commodities or shipping or transport," he said.

The company has warned it could lose sales and market share if cleaner technologies such as electric motors displace gas and diesel engines, where its expertise lies. The company has announced plans to close several production facilities.

A decline in German car production this summer, mainly due to a persistent chip shortage, was the single biggest contributor to the overall drop in industrial output over that period.

German passenger car production



Source: German Association of the Automotive Industry

German auto production has fallen by more than 50% since 2017, to around 200,000 a month. In the nine months through September, it declined slightly from the year-earlier period, compared with a roughly 10% year-over-year increase in global light-vehicle production over the same period. Germany's share of global motor-vehicle production fell from about 7% to 5% in the five years through 2020, the data show.

Germany's automotive industry, by far the biggest in Europe, supports about 800,000 German jobs and accounts for 5% of the nation's overall economic output. Three-quarters of cars made in Germany are exported.

German manufacturers have invested in electric vehicles, but such vehicles require far fewer parts than traditional ones. By 2030, 30% to 50% of all new car registrations in the European Union will need to be for electric cars if the continent is to meet its carbon-dioxide emissions targets, according to Deutsche Bank analysts.

The economy is one of the topics in the negotiations between the center-left Social Democrats, the environmentalist Greens and the pro-market FDP to form a coalition government. On Oct. 15, the three parties disclosed preliminary plans to increase public investments, especially in climate protection, high-speed internet, education, research and infrastructure.

"It will be the biggest industrial modernization project that Germany has carried out probably for over 100 years, and it will really help our economy," said Olaf Scholz, the Social Democrats' leader and likely future German chancellor.

After years of belt-tightening aimed at honing competitiveness, German businesses and the country's public infrastructure are suffering from underinvestment, economists say. Germany's net investment rate has been around 0.5% of economic output since the turn of the century, compared with about 1% for Italy and 1.5% for the U.S., according to the World Bank. German net public investment has fallen below zero as existing assets depreciate.

German auto production has fallen by more than 50% since 2017. New cars in Duisburg, Germany.

PHOTO: MARTIN MEISSNER/ASSOCIATED PRESS

Some economists contend that Germany's small national market means domestic demand alone, even the kind driven by investment rather than just consumption, will never support engineering businesses that often export 80% of their products.

"Germany will always be...an export country," said Gordon Riske, CEO of Kion Group AG , a Frankfurt-based manufacturer of forklift trucks. "For us in particular, the revenue is outside of Germany, and we have to invest where customers are."

Although the winners of September's election have presented the green transition as an economic opportunity, business groups and analysts say it will add costs and endanger jobs. Higher carbon and electricity prices and investments in cleaner production processes and research will eat into already dwindling profits, they warn, especially in a manufacturing-focused, energy-hungry economy.

The country's green-energy transition will require investments of €5 trillion through 2045, or 5.2% of Germany's annual economic output, on average, every year, according to a study published in October by KfW, the state-owned development bank. That is considerably more than the roughly €2 trillion spent reunifying West Germany with the formerly communist East Germany in the two decades after 1990.

SHARE YOUR THOUGHTS

What steps does Germany need to take to catch up economically with the rest of Europe? Join the conversation below.

"Germany's entire business model is at stake," said Oliver Bäte, CEO of German financial-services group Allianz SE. "If we get energy transition wrong, our economic core gets into trouble and an economic crisis becomes inevitable."

Germany's labor force grew by almost four million during Chancellor Angela Merkel's 16-year tenure, as strong growth sucked in older workers and immigrants. The workforce is now projected to shrink by the same amount over the next decade. Experts say reserves of fresh workers in Germany and Eastern Europe may largely be depleted.

Markus Mann, an entrepreneur in rural western Germany whose business manufactures wood pellets for use as fuel, said he recently sent a "Wanted" poster to his 80 employees, promising a €500 reward for new staff referrals. He has raised wages for his staff by 3.5%, around double the usual annual increase. Unemployment in the region is 2.8%. "I need to offer a bounty," he said.

Markus Mann, whose business manufactures wood pellets, has promised employees a €500 reward for new staff referrals.

PHOTO: ANAHIT HAYRAPETYAN FOR THE WALL STREET JOURNAL

The three coalition parties want to cut in half the time it takes for authorities to approve new investment projects, currently a serious hurdle for businessmen like Mr. Mann. Government bureaucracy costs German firms about €55 billion a year, roughly half the total amount invested in research and development, according to Germany's federal statistics agency.

Tesla Inc. hasn't yet received approval for a roughly $6 billion factory outside Berlin that is expected to create 12,000 jobs. The auto maker has been building the plant for almost two years and has delayed its opening from July. The company recently built a factory in Shanghai in less than a year.

Thirty years ago, Mr. Mann said, he borrowed money from his father to build a wind turbine near his home, about 30 miles from the nearest large town. Government approval took three months, and the official assessment covered four sheets of paper and cost about €5,000 in today's money.

More recently, he sought permission to replace his old turbines with new ones that produced 40 times as much energy. This time, the approval process lasted seven years and cost almost €300,000, for an investment worth about €5.5 million, he said.

A spokesman for local authorities said that because the new turbines are much larger than the old ones, they could have a larger environmental effect, and hence require more testing.

ElringKlinger AG , a car-parts manufacturer in southern Germany, has started producing batteries and fuel cells, part of the industry's shift toward cleaner technologies. The new production processes are highly automated, said Chief Executive Stefan Wolf, "which means we need far fewer employees than for building internal-combustion engines." Total employment shrank by about 7% between 2018 and 2020, to about 9,700.

"We have very high labor costs, very high energy costs, and in the last five years, we have seen an enormous increase in bureaucracy," said Mr. Wolf. "Germany might soon be the sick man of Europe again."

Write to Tom Fairless at tom.fairless@wsj.com

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The Need to Examine the Life Cycles of All Energy Sources: A Closer Look at Renewable-Energy Disposal

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KEY TAKEAWAYS

The Biden Administration and some lawmakers are moving forward with a historic shift to "zero emissions" energy production without planning for the aftermath.

Renewable-energy advocates focus on zero emissions without considering the materials used in the production of the source or the ultimate disposal of the byproducts.

The government should not intervene in energy markets, including for renewable resources—but since it is, taxpayers deserve a full accounting of costs and benefits.

Every source of energy—including fossil fuels, wind and solar power, and nuclear power—have both positive and negative attributes. Often, proponents or opponents of a certain source gloss over, or hype up, specific challenges or benefits in order to promote their favored solution. In order to make informed decisions about which energy sources can meet America's energy needs, policymakers and the public need to know about the entire life cycle of all energy sources. For example, proponents of fossil fuels often highlight their affordability and reliability, while ignoring the effects of waste disposal or extraction. Likewise, renewable-energy advocates focus on "zero emissions" without considering the materials used in the production of the source or the ultimate disposal of the byproducts or equipment.

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The environmental life cycle of an energy source can be broadly grouped into three categories: (1) the extraction or production of the source material and the equipment required to do so; (2) the generation of the energy and the resulting emissions; and (3) the waste disposal of the byproducts or equipment. All aspects should be considered when evaluating the best energy source for a given use or purpose, including the benefits and the costs for each.

For years, large provisions of U.S. environmental laws, and their corresponding regulations, have been drafted to address the life cycle challenges of fossil fuels. The effectiveness of the laws and regulations must be constantly re-evaluated to ensure that public health and the environment are protected. For example, numerous laws govern oil extraction, the emissions of the refining process, the impact on water quality, and the disposal of waste materials. The natural gas sector is regulated by rules on fracking, extraction, pipeline emissions, and transportation. Coal is regulated, among other ways, through mining restrictions, limits on emissions from power plants, and the closure of coal-refuge ponds. All fossil fuel sources have historically contributed to the creation of large-scale waste sites addressed under the Superfund program for cleanup, and fossil fuels produce air pollution and greenhouse gases.

But as Congress and the Biden Administration, as well as many states, move to limit or reduce the use of fossil fuels in favor of renewable energy, there has been little or no recognition of the negative life cycle consequences of renewable-energy sources, specifically wind, solar power, and electric batteries. Without a full understanding or debate of the issues, decisions made today will create the environmental problems of tomorrow.

All three primary forms of renewable energy—wind turbines, solar panels, and electric batteries—rely on substantial source materials in the production of the equipment. Solar panels and batteries (and to a lesser extent wind turbines), are highly dependent on mining extraction for rare earth minerals and other components, such as arsenic and gallium (for solar panels) and lithium and manganese (for batteries).[1] The production of the fiberglass windmill blades is both energy intensive and requires substantial energy to transport the component parts. The environmental impact of the mining activities, typically in developing countries, are rarely acknowledged or debated, nor are their mining practices considered. Accusations of child labor and the real environmental degradation due to the lack of meaningful environmental laws or standards are often overlooked.[2]

Proponents of renewable energy focus almost exclusively on the positive attributes of its generation, ignoring the equipment-production and waste-disposal issues. The zero emissions of renewable-energy production are unparalleled as an energy source except for nuclear power. There are negative environmental consequences of generation, though, such as bird deaths on windmill farms, and bird and other wildlife deaths attributed to solar panels.[3,4] However, the difference between renewable energy and fossil fuels in terms of air emissions is stark. Unlike conventional carbon-based fuels, renewable-energy technologies typically do not emit nitrogen oxides, sulfur dioxides, mercury, and other air pollutants or greenhouse gases during energy generation.

The remaining category, waste disposal, is absent in most public policy discussions for renewable-energy sources. The issue itself will grow in importance as the use of renewables increases and older equipment reaches the end of its useful life. The rest of this *Backgrounder* examines some of the waste-disposal issues surrounding renewable-energy sources.

Solar Panels

Solar energy use in the United States has grown from five gigawatt hours (GWh) in 1984 to 133,000 GWh in 2020.[5] Solar panels must be installed by specially trained technicians. The panels can be cumbersome to transport and, since principally made of glass, are breakable. The safe removal of the panels also requires specially trained technicians to ensure possible recycling or the more likely scenario of waste disposal without destroying the materials or releasing the hazardous substances contained within the solar panels.

In the United States, materials are classified as hazardous either because they are a listed hazardous waste under federal law and regulations, or they exhibit hazardous characteristics, such as toxicity. Solar panels themselves are not classified as hazardous but are considered hazardous due to their component materials. Solar panels and photovoltaic (PV) modules contain multiple toxic materials including arsenic, cadmium, copper, lead, selenium, silicon, and silver. The inclusion of these hazardous materials in the solar panels triggers the hazardous waste–transportation and waste-disposal regulations and requirements under the 1976 Resource Conservation and Recovery Act.[6] In addition, there are specific regulations tied to the recycling of products containing hazardous materials.[7]

> The inclusion of hazardous materials in solar panels triggers U.S. hazardous waste-transportation and waste-disposal regulations and requirements.

A majority of states allow the disposal of solar panels in municipal landfills.[8] This could create hazardous waste-cleanup issues well into the future depending on the scale and type of the materials involved. California has moved forward with regulations designating solar panel waste as "universal waste," which offers less stringent regulatory requirements for handling and storage and is meant to encourage recycling, which does not always work.[9] Other examples of universal waste include fluorescent light bulbs and some batteries. Washington State has taken the most aggressive approach in dealing with used solar panels by requiring the manufacturers to finance a takeback and recycling system for all panels sold after July 1, 2017.

While large-scale solar facilities are operated by professional companies that, in theory at least, should implement best-case removal practices, the same cannot be said for individual businesses or homeowners. Requirements differ significantly by state or by locality, with most states not regulating the disposal of solar panels at all. With some solar installations expected to last up to 30 years, it is likely that many installations will no longer be owned by the same homeowner or operated by the same business at the end of their life cycle, complicating long-term planning for disposal services. When it is time for the solar equipment to be replaced, the burden could fall on the new installation company or homeowner. The question would remain as to who bears the cost of safely removing and disposing of the older material.

The materials themselves are capable of being recycled, to some extent, however, the cost is currently prohibitive. The cost to recycle one solar panel is approximately $20 to $30 while the cost to dispose of the same panel at a landfill is $1 to $2.[10] The increasing volume of older solar panels reaching the end of their life cycle, coupled with the higher cost of panel recycling, has prompted many within the industry to store old solar panels until the recycling costs are reduced. This, in turn, creates new handling issues if the panels are not stored correctly or degrade significantly over time in storage releasing the toxic materials. One U.S. manufacturer, First Solar, operates a recycling facility in Ohio that can recycle approximately 90 percent of the semiconductor material and glass collected from its used thin-filmed panels.[11]

One of the approaches in the European Union is to hold manufacturers of solar panels responsible for their disposal at the end of their useful life. Under the waste, electrical, and electronic equipment (WEEE) Directive, producers of solar panels are legally responsible for the collection, treatment, and monitoring of the end-of-life management of their solar panels.[12] A similar approach in the United States would be complicated due to the high volume of imported solar panels. According to the National Renewable Energy Laboratory, PV modules and cell imports are at historically high levels despite tariffs imposed by the United States,[13] and Wood MacKenzie reports that 85 percent of solar panels sold in the U.S. are imported.[14] Since many of the foreign manufacturers are Chinese, there is concern that they may not be solvent or in existence in a generation. This may increase the burden on the U.S. installation industry, the property owners, and the disposal and recycling facilities.

The expected volume of the solar-panel waste stream is staggering, considering America's lack of a PV-waste-management system. The International Renewable Energy Agency projects that up to 78 million metric tons of solar panels will have reached the end of their life by 2050, and that the U.S. will be producing 6 million metric tons of new waste annually.[15] It is estimated that around 26,000 tons of solar panels ended up as waste in 2020 alone, and that number is excepted to increase each year.[16] These projections do not take into account the recent accelerated push for solar power by the United States.

> The U.S. waste-stream system is not equipped to deal with a large influx of solar panels today.

In a recent article in the *Harvard Business Review*,[17] the authors report that the combination of the solar tax credits and the year-over-year diminishing performance of older panels will incentivize property owners to replace their older panels at a much faster rate, accelerating the need to dispose of the older panels now as opposed to in the future. The waste-stream system is not equipped to deal with a large influx of solar panels today. If the panels are simply sent to landfills, there is a real possibility of lead and cadmium leaching into the ground water. Likewise, if the panels are stored indefinitely, they could leach out due to degradation or improper storage. The Superfund sites of the past 40 years were mostly created to clean up the damage caused by the improper disposal or storage of historic waste. This country should not repeat those mistakes with renewable sources.

While there have been some limited advances in the recycling of solar panels in the United States, the amount of the material recycled is just a fraction of the amount of waste produced each year. This will grow exponentially as the older solar panels installed in the early 2000s reach the end of their useful life. This end may be artificially accelerating due to the tax code treatment and the development of more efficient solar panels making older panels obsolete before their time. If the U.S. continues to promote greater usage of solar technologies without solving the waste issues, it will merely punt the not-too-distant—and likely overwhelming—environmental problems a bit further down the road.

Wind Turbines

Wind energy in the United States has grown from 40 GWh in 2011 to more than 118 GWh at the end of 2020.[18] While wind turbines are manufactured in several different designs—from the wind turbines found in increasing numbers across the American landscape, to offshore windmills, to small modular units located on buildings.

Wind turbines in general consist of three distinct parts—the tower, the nacelle, and the rotor blades. The tower, generally constructed of steel, stands up to approximately 295 feet tall and weighs around 19,000 pounds. The nacelle, which holds the gears and the main driveshaft, has a fiberglass shell and weighs around 22,000 pounds. The blades are typically made of fiberglass with a hollow core, although there are experimental blades made from lightweight woods and aluminum. The blades are around 50 feet long and weigh around 2,500 pounds. At the base of each tower is a utility box that converts the energy into electricity and is linked to nearby towers through underground pipes to other turbines and a transformer.[19] Offshore wind turbines are even larger and can reach 410 feet with blades of 623 feet.

The average life span of a wind turbine is only about 20 years before the mechanical and structural components decay to the point of replacement, provided there has been consistent maintenance and upkeep over the life span of the turbine.[20] For example, the gearboxes typically must be replaced every eight to 10 years.

Once a turbine has reached the end of its life span, at least in the U.S. market, there are few options for disposal. Some of the parts can be recycled, but the blades themselves, composed of resin and fiberglass, cannot be easily recycled and mostly end up in landfills. Although GE recently announced a deal to start recycling its blades for use in cement manufacturing, it is unknown how quickly the technology can be widely deployed.[21]

Very few landfills in the U.S. can deal with the extremely large turbine blades, which are only getting larger with technological advances.[22] It is projected that at least 8,000 blades will be retired each of the next four years in the U.S.,[23] and landfill owners have begun to experiment with disposal techniques. First, the transportation of the blades is difficult: In order to fit on three semitrucks, each blade must be cut into three pieces using expensive specialty equipment. The two sites with the most blade-cutting experience are in Iowa and Wyoming, and both have struggled with their disposal.[24]

There is an export market for developing countries, and many wind turbines from Europe and some from the U.S. end up in Latin America, Africa, and parts of Asia. While this may seem like a benevolent gesture, the U.S. is selling turbines that are near the end of their life spans to countries that do not have the same waste-management practices as Western countries do, exacerbating global environmental problems.

> The U.S. sells aged wind turbines to countries with weak waste-management practices, exacerbating global environmental problems.

A recent study from scientists at the Lawrence Berkeley National Laboratory found a significant drop-off in wind-turbine performance after 10 years—corresponding to the expiration of the wind-energy production tax credit (PTC).[25] Their study suggests that regular maintenance drops off after the PTC expiration makes it less economically viable to pay for the maintenance. If this in fact bears out, wind turbines might have an even shorter life span than expected, resulting in an even larger influx of turbines for disposal in the next few years.

Some states, such as North Dakota, have created a decommissioning policy requiring new wind projects to set aside funds to remove and dispose of old turbines at the end of their life spans.[26] But there is no nationwide policy. Ownership of wind farms differs significantly from ownership of solar panels, since wind farms are predominately owned by large utilities or companies that manage the farms on behalf of utilities as opposed to solar-panel installations, which range in ownership from homeowners to large corporations. Despite the relatively smaller universe of wind-farm owners, in most cases, the financial planning for the disposal of the turbines has not occurred. While the disposal of the turbines does not involve the

same level of hazardous materials, the sheer volume of the waste threatens to overwhelm landfills and the disposal process, while the transportation of the components certainly adds negative environmental aspects to the wind-turbine footprint.

Batteries

Battery storage is the key to transforming renewable energy from intermittent to baseload generation. Large-scale battery facilities will be needed to store energy produced at solar and wind farms, and batteries are the key component in making electric vehicles (EVs) feasible.

The large stationary storage facilities built in conjunction with the grid use several different technologies, although more than 90 percent are based on lithium-ion chemistries. (Nickel- and sodium-based batteries account for most of the remaining systems while "flow battery" systems are starting to increase.) In 2010, the U.S. had seven large-scale battery-storage systems accounting for 59 megawatt hours (MWh) of power capacity. By 2018, according to the U.S. Energy Information Administration, the U.S. had 125 systems accounting for 869 MWh of capacity. It is important to note that 53 of the large facilities are co-located with renewable-energy facilities, and that number is expected to double by 2023. Additionally, there is 234 MWh of small-scale storage capacity, with the majority of it in the commercial and industrial sector, and a third in residential properties.[27] The use of large-system and small-system batteries is going to increase quickly over the next few years.

EVs are typically powered with lithium-ion and lithium-polymer batteries. Other types of EV batteries include lead-acid, nickel-cadmium, and nickel-metal hydride. The lithium batteries are very similar in structure to the lithium batteries used in cell phones, computers, and other electronic equipment. The batteries themselves typically contain cobalt, lithium, and nickel, all mined materials, usually from sources outside the U.S.[28] Lithium is mined predominately in Bolivia, Chile, and China. Additionally, the batteries include a number of rare earth minerals, such as neodymium, which is used as part of the motor magnets and mined predominately in China.

EV batteries tend to reach the end of their life cycles with anywhere from 70 percent to 80 percent of their original capacity intact. This is comparable to spent nuclear fuel rods, which maintain up to 80 percent of their fuel capacity when they are discarded. Originally, EV batteries were lead-acid and reached the end of their life after three or four years; over the past 10 years the industry has transitioned to lithium-ion batteries. Today, all electric vehicles sold in the United States come with a warranty of 100,000 miles, or eight years.[29] While

in many cases the fine print specifies that in order to be replaced a battery must be unable to hold any charge, some companies will replace the battery if the charge drops below a 70 percent or 60 percent threshold.[30]

A recent study found that EV batteries lose, on average, 2.3 percent of their capacity each year.[31] However, the life span of the battery depends on individual circumstances. Batteries that are charged too often, or depleted to low levels on a regular basis, degrade faster, as does exposure to heat.[32]

Once an EV battery has reached its end of life, the batteries are either repurposed, refurbished, recycled, or disposed. Some companies are looking at ways of repurposing the batteries for uses that do not require a full charge, such as household-generation storage.[33] Others are refurbishing the batteries, a process that entails disassembling the battery pack individually and testing the cells and replacing any needed parts, which is both cumbersome and expensive. Recycling the batteries must be done by a licensed and trained recycler due to the weight, complexity, and toxic components of the batteries.[34] Finally, batteries are disposed of in landfills, which can cause chemical fires and leach chemicals into the groundwater.

Recycling EV batteries consists of several different practices. The most common recycling method is to shred the battery and then separate the metals using pyrometallurgical techniques (burning). This process wastes most of the lithium. The next most common method is hydrometallurgical metal reclamation, which uses a series of acid washes to separate the materials. The third method of EV battery recycling is physical separation, where the components are physically separated using mechanical processes.

> Only a small number of materials can be reclaimed through recycling, and the process is highly energy intensive.

There are byproducts of all three methods, ranging from acids to slag material, and it is important to note that only a small number of materials can be reclaimed, and the processes are very energy intensive. While it is possible to recycle up to 50 percent of the material in batteries, it is estimated that, worldwide, only 5 percent of batteries are recycled.[35] The recycling process is further complicated because the battery electrolyte is flammable, explosive, and highly toxic, and it forms highly corrosive hydrofluoric acid upon contact with water.[36] It is also more expensive to recover lithium through recycling than it is to mine it, further complicating recycling efforts.

According to the International Energy Agency, there were 10 million EVs on the world's roads at the end of 2020.[37] But in the U.S. last year, only 2 percent of new vehicles sold were EVs.[38] President Joe Biden issued an executive order to increase sales of zero-emission vehicles to 50 percent by 2030 as part of his climate goals.[39] This of course means a large influx of EV batteries. Currently there are no requirements in the U.S. to recycle EV batteries, and consumers and manufacturers are left to their own devices. Many EV manufacturers take back the older batteries upon purchase of a new battery, but there is no requirement. Likewise, there is no federal requirement for the manufacturers on whether they recycle or dispose of the used batteries once collected.[40] While California is currently examining potential requirements, policy recommendations are not expected until 2022.[41] With the anticipated increase in EV sales over the next decade it is imperative that decisions are made today about what to do with the coming onslaught of used EV batteries.

The Infrastructure and Jobs Act[42] passed by the U.S. Senate in August 2021 includes significant funding for battery-recycling pilot programs, a voluntary battery-labeling program, and the development of a regulatory framework for recycling batteries. The act does not address the ultimate waste-disposal issues except by stating that the goal of the recycling section is to reduce waste and that the goal of the voluntary labeling section is to reduce safety concerns regarding the improper disposal of batteries.

Ultimately, regardless of recycling or reuse programs, the hazardous materials in the batteries will eventually reach the end of their life and necessitate disposal. Reliance on pilot grants to solve problems in a nascent industry (battery recycling) would be fine, if not for President Biden's national goal of a 50 percent increase in EV sales by 2030. Americans cannot afford to put off the unanswered question of how to dispose of EV batteries at the same time that the federal government is accelerating their deployment.

Conclusion

As a country and as a society, Americans value and depend on affordable and reliable energy—and Americans have never been more dependent on energy than today. In addition to electricity, heating and cooling, and transportation, Americans now rely on personal devices powered by energy, such as smartphones and computers. Yet the Biden Administration, some in Congress, and several states are moving forward with a historic shift in energy production without planning for the aftermath.

Recycling rates of traditional commodities, such as paper, aluminum, glass, and plastics, are at a 20-year low, yet the government would have Americans believe that they will easily be able to recycle renewable-energy materials and byproducts. Recycling PV modules or EV batteries is simply not feasible if the costs are a magnitude larger than the raw materials. This is the same dilemma as with some plastics and glass recycling, where raw materials are cheaper than the recycling process. And, sending old windmills to developing countries under the guise of recycling only prolongs their disposal, burdening underdeveloped governments that are even less equipped to deal with them than is the United States.

U.S. disposal laws, while equipped to deal with toxic materials related to fossil fuel generation, have yet to be tested by the coming deluge of renewable-energy waste. Granted, the laws and regulations for fossil fuels had to catch up with those waste streams, and some of the sites addressed by the 1980 Superfund law dated back to the 19th century. That is no excuse to delay planning for the environmental problems everyone knows are just down the road.

Today, the Biden Administration and Congress are working overtime to incentivize the use of renewable sources, yet they are not proposing solutions to deal with the renewable waste. If the renewable sources would grow organically at their own pace, instead of a forced, almost exponential, growth, there would be more time to plan for their end-of-life disposal. By forcing this rapid expansion of renewable energy, the Biden Administration is creating future problems while turning a blind eye to desperately needed solutions. If the federal government is so aggressively promoting the use of renewable energy through government regulations and subsidies, it should be responsible for ensuring that the waste-disposal issues are addressed.

Renewable energy is a vital part of Americans' future energy mix, but policymakers must not allow the goal of clean emissions to cloud their judgment or close their eyes to the negative environmental impacts. There are no panaceas for America's energy needs, and policymakers and the public must be willing to look at the positives and negatives of all energy sources.

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GREENWIRE

AUTOMATION AND THE WORKFORCE & 13 OTHERS

Low pay, abusive conditions rife at Congolese cobalt mines — report

BY: JAEL HOLZMAN | 11/08/2021 01:46 PM EST

A new report by British watchdog group RAID finds that workers at industrial cobalt mines in Congo — who dig up a key component of the lithium-ion batteries used in electric vehicles — deal with unsafe working conditions, physical abuse, long hours and extremely low pay. | Francis Chung/E&E News

GREENWIRE | Workers kicked, beaten and flogged by managers. Wages far below sustainable for comfortable human life. Labor agreements that trap employees in a cycle of poverty.

These are the labor conditions for some workers in the largest Congolese cobalt mines at the heart of making the modern electric car, according to a report

released today by British human rights groups RAID and the Centre d'Aide Juridico Judiciaire, or CAJJ, a Congolese legal aid center focused on labor rights.

"The exploitation of workers that we documented in Congo is widespread and systematic, and it taints electric vehicles," RAID Executive Director Anneke Van Woudenberg told E&E News. "Those that want to buy electric vehicles would not be happy if they knew the batteries in those vehicles are tainted by the labor abuses in Congo."

The findings, which were gathered over two years, are the latest allegations of human rights abuses tied to cobalt mining in Congo.

Cobalt, a silvery-blue metal, is a key component of lithium-ion batteries, necessary for not only electric vehicles but a host of consumer products.

Growth in the electric vehicle industry is expected to create an explosion in cobalt demand. The World Bank estimates demand for cobalt will increase by 585 percent by 2050. The clamor for cobalt will also put a larger spotlight on Congo as the country is one of the only places in the world where the mineral can be found in ample supply.

"There are a handful of key minerals that really need the Democratic Republic of the Congo as a key part of their sourcing, because there aren't very many places where these minerals can be found naturally," said Michael Rohwer, director of information and communications technology at BSR, a business sustainability consulting firm.

In the past, claims of human rights problems at Congolese cobalt mines have centered on reports of child labor and unsafe working conditions at artisanal cobalt mines, informally organized mine sites without traditional corporate structures or oversight mechanisms (*Greenwire*, Dec. 15, 2017).

In the wake of those allegations, companies reliant on using cobalt to make their products have pointed to voluntary industry standards for ethical sourcing and emphasized that most cobalt mining in Congo happens not at artisanal mines but at large-scale industrial cobalt mines.

However, this new report specifically examines those large-scale industrial cobalt mines, finding not only low pay and unsafe working conditions, but widespread abuses.

EV companies are acutely vulnerable to reputational risk, BloombergNEF analyst Kwasi Ampofo said in an interview with E&E News in late October.

Customers looking to buy EVs typically want their purchase to be a moral and just action, he noted. As a result, companies selling EVs must prioritize ethical sourcing of their materials. If they don't, they could lose customers.

“It’s become the center of gravity for the whole electrification journey, so automakers don’t have a choice. You either prioritize [ethics] and make it equally important, or you lose out on the energy transition," Ampofo said.

Mines investigated by the human rights groups were linked to supplying cobalt to some of the largest auto manufacturers in the EV marketplace, including Tesla Inc., General Motors Co., Toyota Motor Corp., Volkswagen AG, Volvo Group, Renault Group and Chinese-owned BYD Co. The mines were also linked to technology titans Apple Inc., Panasonic Corp. and Samsung SDI, as well as battery companies Contemporary Amperex Technology Co. Ltd. and LG Chem Ltd.

Many of the manufacturers identified in the report responded to the human rights groups pledging to uphold the highest possible standards on human rights.

In letters published with the report, the companies told the human rights groups they hold their suppliers to high corporate social responsibility standards, check for abuses through independent audits of their supply chains, and work to adhere to international standards set by organizations like the Organization for Economic Cooperation and Development, or OECD.

EV companies also indicated they are trying to improve their supply chains, and acknowledged the industry may have suffered from a blind spot with cobalt mining.

“We recognize that even despite our best efforts, we may not realize the degree of positive impact that we desire. That is why research such as yours can be so

valuable in helping us identify problematic actors or regions," General Motors supply chain manager Fred Gersdorff wrote the advocacy groups in an Oct. 18 email.

'Neo-colonialism'

RAID and CAJJ reviewed five mines owned or operated by multinational mining companies that altogether produced almost half of the global supply of cobalt in 2020: Swiss miner Glencore's Kamoto Copper Co.; Eurasian Resources Group's Metalkol RTR; China Molybdenum's Tenke Fungurume Mining; China Nonferrous Metal Mining Co.'s Société Minière de Deziwa, or Somidezl; and Sino-congolaise des Mines, or Sicomines, a joint venture between a Congolese state-owned company and a consortium of Chinese firms and investors.

They found that at these mines, labor conditions have deteriorated as cobalt has risen in demand, with some workers being paid far below a livable wage. By relying on subcontractors to lower overhead costs, the companies offered workers health benefits so scant that they cannot afford malaria tests for their families.

Under these conditions, mine employees reported working extremely long hours and were rarely offered protective health and safety gear, potentially contributing to workers getting lifelong illnesses such as silicosis or lung cancer, according to the report.

The groups also discovered that at large mines operated by Chinese-owned companies, Congolese workers reported being subjected to violence at the hands of managers, recalling instances where mine employees were hit, kicked and beaten with shovels by managers.

The report includes anecdotes of racist workplace expectations, such as Congolese workers being required to address Chinese employees as superiors even if both people held the same job.

"Conditions for workers have worsened," said one anonymous worker interviewed by the human rights groups and quoted in the report. "Chinese companies are imposing their standards and culture in a way that amounts to neo-colonialism."

Of the five cobalt miners referenced in the report, four responded to inquiries submitted by the human rights groups for inclusion. Only one, Glencore, said it suspended an undisclosed number of deals with subcontractors in response to human rights concerns.

Van Woudenberg said the aim of the report was to expose problems so regulators and consumers around the world are aware of the labor conditions at cobalt mines. The hope, she said, is that the findings demonstrate more needs to be done to hold the companies reliant on cobalt accountable.

"We're not asking the Earth here, or even the moon. What we're asking here should be a critically important part of the transition, to tackle the climate crisis," Van Woudenberg said.

REPORT | July 2020

MINES, MINERALS, AND "GREEN" ENERGY: A REALITY CHECK

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About the Author

Mark P. Mills is a senior fellow at the Manhattan Institute and a faculty fellow at Northwestern University's McCormick School of Engineering and Applied Science, where he co-directs an Institute on Manufacturing Science and Innovation. He is also a strategic partner with Cottonwood Venture Partners (an energy-tech venture fund). Previously, Mills cofounded Digital Power Capital, a boutique venture fund, and was chairman and CTO of ICx Technologies, helping take it public in 2007. Mills is a regular contributor to Forbes.com and is author of *Digital Cathedrals* (2020) and *Work in the Age of Robots* (2018). He is also coauthor of *The Bottomless Well: The Twilight of Fuel, the Virtue of Waste*, and *Why We Will Never Run Out of Energy* (2005).

His articles have been published in the *Wall Street Journal*, *USA Today*, and Real Clear. Mills has appeared as a guest on CNN, Fox, NBC, PBS, and The Daily Show with Jon Stewart. In 2016, Mills was named "Energy Writer of the Year" by the American Energy Society. Earlier, Mills was a technology advisor for Bank of America Securities and coauthor of the *Huber-Mills Digital Power Report*, a tech investment newsletter. He has testified before Congress and briefed numerous state public-service commissions and legislators.

Mills served in the White House Science Office under President Reagan and subsequently provided science and technology policy counsel to numerous private-sector firms, the Department of Energy, and U.S. research laboratories.

Early in his career, Mills was an experimental physicist and development engineer at Bell Northern Research (Canada's Bell Labs) and at the RCA David Sarnoff Research Center on microprocessors, fiber optics, missile guidance, earning several patents for his work. He holds a degree in physics from Queen's University in Ontario, Canada

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Executive Summary

As policymakers have shifted focus from pandemic challenges to economic recovery, infrastructure plans are once more being actively discussed, including those relating to energy. Green energy advocates are doubling down on pressure to continue, or even increase, the use of wind, solar power, and electric cars. Left out of the discussion is any serious consideration of the broad environmental and supply-chain implications of renewable energy.

As I explored in a previous paper, "The New Energy Economy: An Exercise in Magical Thinking,"[1] many enthusiasts believe things that are not possible when it comes to the physics of fueling society, not least the magical belief that "clean-tech" energy can echo the velocity of the progress of digital technologies. It cannot.

This paper turns to a different reality: all energy-producing machinery must be fabricated from materials extracted from the earth. No energy system, in short, is actually "renewable," since all machines require the continual mining and processing of millions of tons of primary materials and the disposal of hardware that inevitably wears out. Compared with hydrocarbons, green machines entail, on average, a 10-fold increase in the quantities of materials extracted and processed to produce the same amount of energy.

This means that any significant expansion of today's modest level of green energy—currently less than 4% of the country's total consumption (versus 56% from oil and gas)—will create an unprecedented increase in global mining for needed minerals, radically exacerbate existing environmental and labor challenges in emerging markets (where many mines are located), and dramatically increase U.S. imports and the vulnerability of America's energy supply chain.

As recently as 1990, the U.S. was the world's number-one producer of minerals. Today, it is in seventh place. Even though the nation has vast mineral reserves worth trillions of dollars, America is now 100% dependent on imports for some 17 key minerals, and, for another 29, over half of domestic needs are imported.

Among the material realities of green energy:

- Building wind turbines and solar panels to generate electricity, as well as batteries to fuel electric vehicles, requires, on average, more than 10 times the quantity of materials, compared with building machines using hydrocarbons to deliver the same amount of energy to society.
- A single electric car contains more cobalt than 1,000 smartphone batteries; the blades on a single wind turbine have more plastic than 5 million smartphones; and a solar array that can power one data center uses more glass than 50 million phones.
- Replacing hydrocarbons with green machines under current plans—never mind aspirations for far greater expansion—will vastly increase the mining of various critical minerals around the world. For example, a single electric car battery weighing 1,000 pounds requires extracting and processing some 500,000 pounds of materials. Averaged over a battery's life, each mile of driving an electric car "consumes" five pounds of earth. Using an internal combustion engine consumes about 0.2 pounds of liquids per mile.
- Oil, natural gas, and coal are needed to produce the concrete, steel, plastics, and purified minerals used to build green machines. The energy equivalent of 100 barrels of oil is used in the processes to fabricate a single battery that can store the equivalent of one barrel of oil.
- By 2050, with current plans, the quantity of worn-out solar panels—much of it nonrecyclable—will constitute double the tonnage of all today's global plastic waste, along with over 3 million tons per year of unrecyclable plastics from worn-out wind turbine blades. By 2030, more than 10 million tons per year of batteries will become garbage.

MINES, MINERALS, AND "GREEN" ENERGY: A REALITY CHECK

It's a Material World

How much does a mile of travel or a movie weigh? Such an odd-sounding question isn't about distance or time; instead, it points to the inescapable reality that every product and service begins with, and is sustained by, extracting minerals from the earth.

For everything built or fabricated, one can trace a straight line back upstream to where people use heavy equipment (in some countries, just shovels) to extract materials from the earth. It is obvious that there is a measurable weight in the materials used to build bridges, skyscrapers, and cars. Less obvious is the weight of materials needed to produce energy. Different forms of energy involve radically different types and quantities of energy-harvesting machines and therefore different kinds and quantities of materials.

Whether it's liquids extracted from the earth to power an internal combustion engine or solids used to build batteries, any significant increase in materials used per mile will add up because Americans alone drive some 3 trillion road-miles a year. The same is true for delivering kilowatt-hours and all other energy uses. The upstream nature of the underlying minerals and materials needed for civilization has always been important. It is critical now that governments around the world are rushing to embrace renewable energy.

All machines wear out, and there is nothing actually renewable about green machines, since one must engage in continual extraction of materials to build new ones and replace those that wear out. All this requires mining, processing, transportation, and, ultimately, the disposing of millions of tons of materials, much of it functionally or economically unrecyclable.

Assuring access to the minerals that undergird society is a very old concern, one that is woven through history and has even precipitated wars. In the modern era, U.S. policies to address mineral dependencies date to 1922, when Congress, in the aftermath of World War I, developed a list of 42 "strategic and critical materials" for the technologies and machines important to the military at that time.[2]

Next came the Strategic Materials Act of 1939, renewed and modified several times since, incorporating ideas to encourage domestic mining and create stockpiles of strategically critical minerals for military equipment.

Over the past century, there have been two significant developments. First, the U.S. has not expanded domestic mining, and, in most cases, the country's production of nearly all minerals has declined. Second, the demand for minerals has dramatically increased. These two intersecting trends have led to significant transformations in supply-chain dependencies. Imports today account for 100% of some 17 critical minerals, and, for 29 others, net imports account for more than half of demand.[3]

The Material Cost of "Clean Tech"

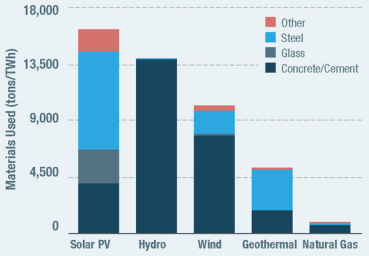
The materials extracted from the earth to fabricate wind turbines, solar panels, and batteries (to store grid electricity or power electric vehicles) are out of sight, located at remote quarries, mine sites, and mineral-processing facilities around the world. Those locations matter in terms of geopolitics and supply-chain risks, as well as in environmental terms. Before considering the supply chain, it is important to understand the scale of the material demands. For green energy, it all begins with the fact that such sources are land-intensive and very diffuse.

For example, replacing the energy output from a single 100-MW natural gas-fired turbine, itself about the size of a residential house (producing enough electricity for 75,000 homes), requires at least 20 wind turbines, each one about the size of the Washington Monument, occupying some 10 square miles of land.[4] Building those wind machines consumes enormous quantities of conventional materials, including concrete, steel, and fiberglass, along with less common materials, including "rare earth" elements such as dysprosium. A World Bank study noted what every mining engineer knows: "[T]echnologies assumed to populate the clean energy shift ... are in fact significantly more material intensive in their composition than current traditional fossil-fuel-based energy supply systems."[5]

All forms of green energy require roughly comparable quantities of materials in order to build machines that capture nature's flows: sun, wind, and water. Wind farms come close to matching hydro dams in material consumption, and solar farms outstrip both. In all three cases, the largest share of the tonnage is found in conventional materials like concrete, steel, and glass. Compared with a natural gas power plant, all three require at least 10 times as many total tons mined, moved, and converted into machines to deliver the same quantity of energy (**Figure 1**).

FIGURE 1.

Materials Requirements to Build Different Energy Machines



Source: U.S. Department of Energy (DOE), "Quadrennial Technology Review: An Assessment of Energy Technologies and Research Opportunities," September 2015, p. 390

Chart: Manhattan Institute

For example, building a *single* 100-MW wind farm—never mind thousands of them—requires some 30,000 tons of iron ore and 50,000 tons of concrete, as well as 900 tons of nonrecyclable plastics for the huge blades.[6] With solar hardware, the tonnage in cement, steel, and glass is 150% greater than for wind, for the same energy output.[7]

If episodic sources of energy (wind and solar) are to be used to supply power 24/7, even greater quantities of materials will be required. One needs to build additional machines, roughly two to three times as many, in order to produce and store energy when the sun and wind are available, for use at times when they are not. Then there are the additional materials required to build electricity storage. For context, a utility-scale storage system sufficient for the above-noted 100-MW wind farm would entail using at least 10,000 tons of Tesla-class batteries.

The handling and processing of such large quantities of materials entails its own energy costs as well as associated environmental implications, explored below. But first, the critical supply-chain issue is not so much the increase in the use of common (though energy-intensive) materials such as concrete and glass. The core challenges for the supply chain and the environment reside with the need for radical increases in the quantities of a wide variety of minerals.

The world currently mines about 7,000 tons per year of neodymium, for example, one of numerous key elements used in fabricating the electrical systems for wind turbines. Current clean-energy scenarios imagined by the World Bank (and many others) will require a 1,000%–4,000% increase in neodymium supply in the coming several decades.[8] While there are differing underlying assumptions used in various analyses of mineral requirements for green energy, all reach the same range of conclusions. For example, the mining of indium, used in fabricating electricity-generating solar semiconductors, will need to increase as much as 8,000%. The mining of cobalt for batteries will need to grow 300%–800%.[9] Lithium production, used for electric cars (never mind the grid), will need to rise more than 2,000%.[10] The Institute for Sustainable Futures

500,000 Pounds: Total Materials Extracted and Processed per Electric Car Battery

A lithium EV battery weighs about 1,000 pounds.[a] While there are dozens of variations, such a battery typically contains about 25 pounds of lithium, 30 pounds of cobalt, 60 pounds of nickel, 110 pounds of graphite, 90 pounds of copper,[b] about 400 pounds of steel, aluminum, and various plastic components.[c]

Looking upstream at the ore grades, one can estimate the typical quantity of rock that must be extracted from the earth and processed to yield the pure minerals needed to fabricate that single battery:

- Lithium brines typically contain less than 0.1% lithium, so that entails some 25,000 pounds of brines to get the 25 pounds of pure lithium.[d]
- Cobalt ore grades average about 0.1%, thus nearly 30,000 pounds of ore.[e]
- Nickel ore grades average about 1%, thus about 6,000 pounds of ore.[f]
- Graphite ore is typically 10%, thus about 1,000 pounds per battery.[g]
- Copper at about 0.6% in the ore, thus about 25,000 pounds of ore per battery.[h]

In total then, acquiring just these five elements to produce the 1,000-pound EV battery requires mining about 90,000 pounds of ore. To properly account for all of the earth moved though—which is relevant to the overall environmental footprint, and mining machinery energy use—one needs to estimate the overburden, or the materials first dug up to get to the ore. Depending on ore type and location, overburden ranges from about 3 to 20 tons of earth removed to access each ton of ore.[i]

This means that accessing about 90,000 pounds of ore requires digging and moving between 200,000 and over 1,500,000 pounds of earth—a rough average of more than 500,000 pounds per battery. The precise number will vary for different battery chemistry formulations, and because different regions have widely variable ore grades. It bears noting that this total material footprint does not include the large quantities of materials and chemicals used to process and refine all the various ores. Nor have we counted other materials used when compared with a conventional car, such as replacing steel with aluminum to offset the weight penalty of the battery, or the supply chain for rare earth elements used in electric motors (e.g., neodymium, dysprosium).[j] Also excluded from this tally: the related, but non-battery, electrical systems in an EV use some 300% more overall copper used compared with a conventional automobile.[k]

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[a] Helena Berg and Mats Zackrisson, "Perspectives on Environmental and Cost Assessment of Lithium Metal Negative Electrodes in Electric Vehicle Traction Batteries," *Journal of Power Sources* 415 (March 2019): 83–90.

[b] Marcelo Azevedo et al., "Lithium and Cobalt: A Tale of Two Commodities," McKinsey & Company, June 22, 2018; Matt Badiali, "Tesla Can't Make Electric Cars Without Copper," Banyan Hill, Nov. 3, 2017; Amit Katwala, "The Spiraling Environmental Cost of Our Lithium Battery Addiction," *Wired*, Aug. 5, 2018.

[c] Paul Gait, "Raw Material Bottlenecks and Commodity Winners," in *Electric Revolution: Investing in the Car of the Future, Bernstein Global Research*, March 2017; Fred Lambert, "Breakdown of Raw Materials in Tesla's Batteries and Possible Bottlenecks," electrek.co, Nov. 1, 2016; Matt Bohlsen, "A Look at the Impact of Electric Vehicles on the Nickel Sector," Seeking Alpha, Mar. 7, 2017.

[d] Hanna Vikström, et al., "Lithium Availability and Future Production Outlooks," *Applied Energy* 110 (2013): 252–66.

[e] John F. Slack et al., "Cobalt," in *Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply*, USGS Professional Paper 1802, Dec. 19, 2017.

[f] Vladmir I. Berger et al., "Ni-Co Laterite Deposits of the World—Database and Grade and Tonnage Models," USGS Open-File Report 2011-1058 (2011).

[g] Gilpin R. Robinson Jr. et al., "Graphite," in *Critical Mineral Resources of the United States*.

[h] Guiomar Calvo et al., "Decreasing Ore Grades in Global Metallic Mining: A Theoretical Issue or a Global Reality?" *Resources* 5, no. 4 (December 2016): 1–14; Vladimir Basov, "The World's Top 10 Highest-Grade Copper Mines," mining.com, Feb. 19, 2017; EPA, "TENORM: Copper Mining and Production Wastes": "Several hundred metric tons of ore must be handled for each metric ton of copper metal produced."

[i] DOE, Industrial Technologies Program, *Mining Industry Bandwidth Study*, prepared by BCS, Inc., June 2007;Glencore McArthur River Mine, "Overburden." The seven tons of overburden per ton of ore mined is highly variable.

[j] Jeff Desjardins, "Extraordinary Raw Materials in a Tesla Model S," visualcapitalist.com, Mar. 7, 2016; Laura Talens Peiró and Gara Villalba Méndez, "Material and Energy Requirement for Rare Earth Production," *JOM* 65, no. 10 (October 2013): 1327–40.

[k] Copper Development Association, "Copper Drives Electric Vehicles," 2018.

at the University of Technology Sydney, Australia last year analyzed 14 metals essential to building clean-tech machines, concluding that the supply of elements such as nickel, dysprosium, and tellurium will need to increase 200%–600%.[11]

The implications of such remarkable increases in the demand for energy minerals have not been entirely ignored, at least in Europe. A Dutch government-sponsored study concluded that the Netherlands' green ambitions alone would consume a major share of global minerals. "Exponential growth in [global] renewable energy production capacity," the study noted, "is not possible with present-day technologies and annual metal production."[12]

Behind the Scenes: Ore Grades and "Overburden"

The scale of these material demands understates the total tonnage of the earth that is necessarily moved and processed. That is because forecasts of future mineral demands focus on counting the quantity of refined, pure elements needed—but not the overall amount of earth that must be dug up, moved, and processed.

For every ton of a purified element, a far greater tonnage of ore must be physically moved and processed. That is a reality for all elements, expressed by geologists as an ore grade: the percentage of the rock that contains the sought-after element. While ore grades vary widely, copper ores typically contain only about a half-percent, by weight, of the element itself: thus, roughly 200 tons of ore are dug up, moved, crushed, and processed to get to one ton of copper. For rare earths, some 20 to 160 tons of ore are mined per ton of element.[13] For cobalt, roughly 1,500 tons of ore are mined to get to one ton of the element.

In the calculus of economic and environmental costs, one must also include the so-called overburden—the tons of rocks and dirt that are first removed to get access to often deeply buried mineral-bearing ore. While overburden ratios also vary widely, it is common to see three to seven tons of earth moved to get access to one ton of ore.[14]

For a snapshot of what all this points to regarding the total materials footprint of the green energy path, consider the supply chain for an electric car battery. A single battery providing a useful driving range weighs about 1,000 pounds.[15] Providing the refined minerals needed to fabricate a single EV battery requires the mining, moving, and processing of more than 500,000 pounds of materials somewhere on the planet (see sidebar on p.7).[16] That's 20 times more than the 25,000 pounds of petroleum that an internal combustion engine uses over the life of a car.

The core issue here for a green energy future is not whether there are enough elements in the earth's crust to meet demand; there are. Most elements are quite abundant, and nearly all are far more common than gold. Obtaining sufficient quantities of nature's elements, at a price that markets can tolerate, is fundamentally determined by technology and access to the land where they are buried. The latter is mainly about government permissions.

However, as the World Bank cautions, the materials implications of a "clean tech" future creates "a new suite of challenges for the sustainable development of minerals and resources."[17] Some minerals are difficult to obtain for technical reasons inherent in the geophysics. It is in the underlying physics of extraction and physical chemistry of refinement that we find the realities of unsustainable green energy at the scales that many propose.

Sustainability: Hidden Costs of Materials

Concerns about the environmental and health effects of mining were first expressed by the ancient Greek physician Hippocrates, in his book *De aëre, aquis et locis* (*On Air, Waters, and Places*).[18] Since civilization could not exist without extracting minerals from the earth, society has long had to contend with the challenges associated with the responsible extraction of resources.

Today, the most dramatic factor driving the scale of future global mining is not the creation of products that require new uses of minerals (e.g., silicon for computers, aluminum for aircraft) but the push to use green machines to replace hydrocarbons to meet existing energy demands. Green machines mean mining more *materials per unit of energy* delivered to society. Since clean tech is about supplying energy in a more "sustainable" fashion, one needs to consider not just the physical mining realities but also the hidden energy costs of the underlying materials themselves, i.e., the "embodied" energy costs.

Embodied energy arises from the fuel used to dig up and move earth, grind and chemically separate minerals from the ores, refine the elements to purity, and fabricate the final product. Embodied energy costs can

add up to surprising levels. For example, while an automobile weighs about 10,000 times more than a smartphone, the car requires only 400 times more energy to fabricate. And the world produces nearly 600,000 *tons* of consumer electronics annually.[19] Epitomizing this reality: the embodied energy to produce about 200 pounds of steel is the same as used to produce one pound of semiconductor-grade silicon.[20] The world also uses some 25,000 *tons* of (energy-intensive) pure semiconductor-grade silicon, a nonexistent material in the precomputer era.[21]

Embodied energy use starts with the fuel used by giant mining machines, such as the 0.3 mpg Caterpillar 797F, which can carry 400 tons of ore. There are also energy costs for electricity at the mine site (in remote areas, often diesel-powered) to run machines that crush rocks, as well as the energy costs in producing and using chemicals for refining. For minerals with very low ore grades, fuel can be a significant factor in the cost of the final product.

Rare earth elements, used in all manner of tech machines, including green ones, have rare properties but are much more abundant than gold. However, the physical chemistry of rare earths makes them difficult and energy-intensive to refine. It takes about twice as much energy to get access to and refine a pound of rare earth as a pound of lead, for example.[22]

For the mining industry, there is nothing new or sur-prising about the quantities of energy and chemicals used in the multistep processes needed to purify min-erals locked up in rocks. While there are always ways (including, these days, with digital tools) to improve economic efficiency—and improve safety and environ-mental outcomes—research shows that, with regard to *energy e iciency*, the majority of the underlying mineral processes themselves already operate near technical or physics limits.[23]

This means that, for the usefully foreseeable future, increasing the production of green machines will un-avoidably increase embodied energy. For example, analyses show that manufacturing a single battery, one capable of holding energy that is equivalent to one barrel of oil, entails processes that use the energy equivalent of 100 barrels of oil.[24] About half that energy is in the form of electricity and natural gas, and the other half oil. If the batteries are manufactured in Asia (as 60% of the world's batteries are now), more than 60% of the electricity to do so is coal-fired.[25]

Embodied energy is also necessarily a part of building wind and solar machines, especially since large quantities of concrete, steel, and glass are required.[26] These commodity materials have relatively low embodied energy per pound, but the number of pounds involved is enormous.[27] Natural gas accounts for over 70% of the energy used to fabricate glass, for example.[28] Glass ac-counts for some 20% of the tonnage needed to build solar arrays. For wind turbines, oil and natural gas are used to fabricate fiberglass blades, and coal is used to make steel and concrete. Some perspective: if wind tur-bines were to supply half the world's electricity, nearly 2 billion tons of coal would have to be consumed to produce the concrete and steel, along with 1.5 billion barrels of oil to make the composite blades.[29]

One additional energy factor absent from analyses of the embodied energy of clean-tech machines is in how the materials are delivered. More than 75% of all oil and 100% of natural gas are transported to markets via pipelines.[30] (Most of the remaining ton-miles take place on ships.) Pipelines are the world's most energy-efficient means of moving a ton of material. However, nearly all the materials used to construct green machines are solids, and a very large share will be transported by truck. Using trucks instead of pipelines entails a 1,000% increase per ton-mile in the embodied transportation of energy materials.[31]

Finally, in any full accounting of environmental realities, there is the disposal challenge inherent in the very large quantities of batteries, wind turbines, and solar cells after they wear out, a subject discussed below. For now, it bears noting that many wind turbines are already reaching their 20-year end of life; decommis-sioning and disposal realities are just beginning. The massive, reinforced fiberglass (plastic) blades are very expensive to cut up and handle, are composed of non-recyclable materials, and will end up in a landfill. As for solar farms, the International Renewable Energy Agency forecasts that by 2050, with current plans, solar garbage will constitute double the tonnage of all global plastic waste.[32]

For many green energy proponents, the solution to all these challenges with materials is found in a well-worn call for greater attention to "reduce, reuse, and recycle." Many people also take refuge in the belief that our future has room in it for more energy mate-rials because technology is "dematerializing" the rest of society. In reality, neither dematerialization nor re-cycling offers a solution to the heavy costs of a green energy future.

The "Dematerialization" Trope

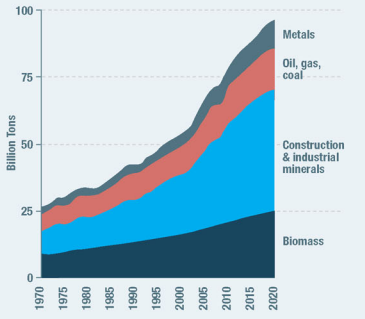
There is a popular claim in our digital times that the increasingly service-dominated economy, combined with the Amazonification and Uberization of everything, means that "the need for resource-intensive manufacturing is not inevitable."[33] Or, as MIT scientist Andrew McAfee put it: "For just about all of human history our prosperity has been tightly coupled to our ability to take resources from the earth. . . . But not anymore."[34]

It is true that resource extraction—food, fuel, and minerals—accounts for only a minor share of America's overall GDP; that has been true for more than a century. However, the foundational requirement for any of those inputs has not decreased in absolute quantity, nor has there been a diminution of the importance of the reliability and security of the supply, and price, of those inputs.

For evidence that society is not dematerializing in any fundamental way, we need only compare two iconic products of this and the past century: the smartphone and the automobile. These two products characterize a cultural shift and an apparent shift in material dependencies. As one analyst put it, teenagers have gone from driving cars to the mall to purchase music cassettes to streaming music digitally.[35] But the digital world has not eliminated the use of automobiles or the surprising quantities of minerals and materials used in the upstream production of all things digital. Forecasts for the next two decades see a 300% rise in global demand for common materials such as plastics, paper, iron, aluminum, silica (sand), and calcium (in limestone) for concrete.[36]

FIGURE 2.

Global Use of Materials



Source: Gillian Foster et al., "Sustainable Consumption and Production," in Stephan Lutter, Fred Luks, and Sigrid Stagl, eds., *Towards a Socio-Ecological Transformation of the Economy*, Institute for Ecological Economics / Vienna University of Economics and Business (January 2019); Circle Economy, "Circularity Gap Report 2020"

Chart: Manhattan Institute

Wealthy economies have become more efficient, and the rate of economic growth has outpaced a slower rise in overall material use. But greater economic efficiency in material use *slows the growth rate*—it is not a fundamental decoupling of materials from growth. The world consumes over 100 billion tons each year in materials for construction, food, fuel, and metal parts (**Figure 2**).[37] That averages out to over 2 million pounds for each person's lifetime on the planet. More than 85% of that, so far, is for nonenergy purposes.

Still, it is true that eventually—even if it is a century from now—there will be a slowing in demand for everyday materials as poorer nations approach a saturation level of per-capita use of food, homes, roads, and buildings.[38] We are a long way away from such saturation: wealthy nations have about 800 cars per 1,000 people, while in countries where billions of poorer people live, the ratio is closer to 800 people per single car.[39] To the extent that a rising share of those cars are electric, the demand for a wide variety of minerals will grow even faster.[40]

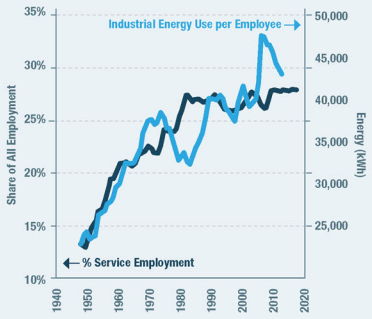
Moreover, the continual discovery of novel properties in elements drives entirely new demands for mining. A century ago, cars were manufactured using a handful of materials: wood, rubber, glass, iron, copper, vanadium, and zinc. Cars today are built from more than three dozen nonfuel minerals, including a mélange of 16 rare earth elements. One example: in 1982, a General Motors scientist employed the rare properties of neodymium to invent the world's strongest magnet.[41] Such magnets, 10 times more powerful than anything previous, are now integral to all manner of products, including green products such as wind turbines and electric cars.

The service sector had become the primary source of employment by the end of the 20th century.[42] Most analyses and anxieties have focused on the implications of this transformation for the workforce.[43] Yet all services are also based on the use of manufactured products.[44]

There is no FedEx without trucks and aircraft; there is no health care without hospitals, magnetic imaging machines, and pharmaceuticals; there is no Amazon

FIGURE 3.

Share of Employment in Services vs. Energy Use per Worker



Source: Blair Fix, "Dematerialization Through Services: Evaluating the Evidence," *BioPhysical Economics and Resource Quality* 4, no. 6 (March 2019), fig. 6

Chart: Manhattan Institute

without data centers and warehouses. The convenience of "one-click" shopping and one- or two-day deliveries over the past half-dozen years has led to a doubling in U.S. warehouse construction and 50% rise in freight traffic.[45] Building the Cloud begins with the periodic table, from silicon and arsenic to lithium and ytterbium. Powering the Cloud requires the use of sand and steel to obtain natural gas locked up in shale, as well as silver and selenium to get solar energy.

Consider an important material-service linkage visible in energy trends. Since the start of the digital age, circa 1980, the average material intensity of America—measured in total pounds used per capita, not total pounds overall—has remained largely unchanged.[46] But the realities of how energy is used by machines, and to fabricate those machines, can be seen in the trend in energy use per industrial worker, which has increased right along with the rising share of total employment that is nonindustrial.[47] In fact, in the digitally infused period since 1980, the share of employment in services remained flat while the energy intensity of the average industrial-sector employee increased (**Figure 3**). In short, migration to a more service-dominated economy does not reduce dependence on energy, and derivatively materials, or the need for reliable access to both.

Reduce, Reuse, Recycle: No Exit from Mineral Dependencies

The mantra to "reduce, reuse, and recycle" ingrained in modern culture has become a feature in virtually all analyses and policy proposals directed at finding a way to reduce the materials demands of green energy. Reuse is generally irrelevant, since the vast majority of all products in society cannot be reused, and this includes green energy machines. The technical and environmental challenges, and thus the costs to reuse, more often than not are greater than those associated with using virgin material.

Reduce

Modern "reduce and recycle" policies and mandates were motivated in large measure by the goal to reduce the amount of trash going to landfills. So what will become of the rapidly increasing number of wind/solar/battery machines that are being produced? Answer: nearly all of them will eventually show up in waste dumps.

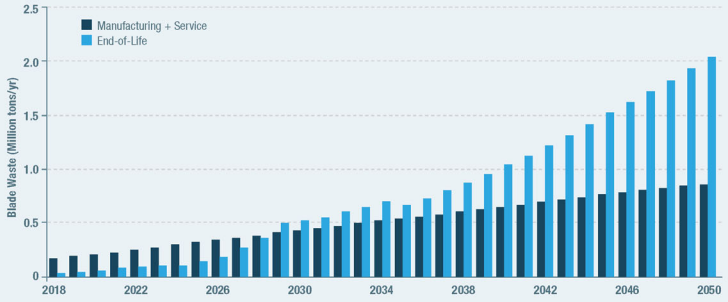
As we noted earlier, the International Renewable Energy Agency (IRENA) forecasts that by 2050, with current plans, solar garbage will constitute double the tonnage of all forms of global plastic waste. Similar scales are expected from end-of-life batteries used in electric cars and on power grids. China's annual battery trash alone is already estimated to reach 500,000 tons in 2020. It will exceed 2 million tons per year by 2030.[48] Currently, less than 5% of such batteries are recycled.[49]

When the 20 wind turbines that constitute just one small 100-MW wind farm wear out, decommissioning and trashing them will lead to fourfold more nonrecyclable plastic trash than all the world's (recyclable) plastic straws combined.[50] There are 1,000 times more wind turbines than that in the world today. If current International Energy Agency (IEA) forecasts are met, there will be over 3 million tons per year of unrecyclable plastic turbine blades by 2050 (**Figure 4**).

Recognizing the material intensity of clean energy technologies, some environmentalists suggest that what we need for a "real sustainable future is one that doesn't involve most people driving vehicles."[51] Proposals for encouraging or enforcing lifestyle changes are not new. They are no more likely to be effective in the future than they have been in the past.

FIGURE 4.

Annual Production of Waste from Global Wind Turbine Blades



Source: Pu Liu and Clare Y. Barlow, "Wind Turbine Blade Waste in 2050," *Waste Management* 62 (April 2017): 229–40

Chart: Manhattan Institute

Innovative engineering can lead to modest reductions in the use of some critical elements in electric motors and magnets. But that only slightly slows the rate of growth in demand. It doesn't eliminate the fact that building green machines is made possible by using the properties of many specific elements. For example: samarium enables smaller and more powerful magnets that are also far more stable at high temperatures. Lithium is, tautologically, the essential element in a lithium-ion battery; and copper remains the best option for electric conductors.

Recycle

For green energy advocates, the idealized vision for recycling encompasses deploying a "circular economy" as a number-one priority for dealing with the material implications of clean tech.[52] But the idea of a green energy circular economy based on the goal of 100% recycling is a pipe dream.[53]

Many materials, especially high-value metals, *can* be significantly recycled. But we can consider the implications and lessons for green waste by looking at the 50 million tons of so-called e-waste generated globally from worn-out or outmoded digital devices that are also built using many critical and rare minerals. The tonnage of global e-waste equals "the weight of all commercial aircraft ever built" and is forecast to double in the next several decades.[54]

The millions of tons of e-waste contain hundreds of tons of gold and thousands of tons of silver (generally the primary target of recyclers, for obvious reasons) as well as more than a dozen other elements.[55] In order to increase e-waste recycling from today's 20% level, the World Economic Forum (among others) proposes various measures to increase consumer "awareness," add new regulations and subsidies, and push to redesign the original devices. The Forum estimates that these efforts would reduce consumer costs by 14% over the next two decades.[56]

But as the scale of global recycling grows, many governments and some environmental organizations are beginning to focus on the serious health and safety issues that have been ignored.[57] So far, the majority of e-waste recycling—as is much other waste—takes place in poorer nations willing to undertake the labor-intensive, largely unregulated, and sometimes hazardous processes involved. Ghana, for example, is where Europe exports the largest quantity of its e-waste.[58] Meantime, the global recycling industry is still adjusting to a new reality: two years ago, China abruptly banned the importation of waste, asserting that much of it was "dirty" and "hazardous."[59]

China's ban is forcing local U.S. governments and municipalities to reduce or even halt recycling programs.[60] As one industry expert in Oregon observed: "Recycling is like a religion here. . . . It has been meaningful for people in Oregon to recycle, [and] they feel like they are doing something good for the planet—and now they are having the rug pulled out from under them."[61] The China ban has spotlighted the inherent challenges with recycling, especially the notion of a "circular economy."

The challenge with recycling trace minerals is essentially the same as in mining itself: much depends on concentrations. The concentration of useful minerals in e-waste and green waste is very low and often far lower than the ore grades of those minerals in rocks. In addition, the physical nature of trashed hardware is highly varied (again, unlike rocks), making it a challenge to find simple mechanisms to separate out the minerals. Recycling processes are often labor-intensive (hence the pursuit of cheap labor, sometimes child labor, overseas) and hazardous because techniques to burn away unwanted packaging can release toxic fumes.[62]

If "urban mining"—the oft-used locution for capturing minerals hidden in worn-out products—were easier, cheaper, and safer than mining new materials, there would be a lot more of it, and it would not require subsidies and mandates to put into effect. While technology, especially automation and robotics, will eventually bring more economically viable and cleaner ways to recycle, the challenges are daunting and progress has been slow. That's the reason that the overall global levels of net recycling and capture of most metals (for all purposes, not just e-waste and green waste) are below 20%, and much lower than those for all the rare earths.[63]

Even as Apple has championed recycling programs for its products—including inventing a robot to disassemble iPhones (it can only do iPhones)[64] and opening a new Material Recovery Lab in Austin, Texas—the company, along with many other tech companies, vigorously promotes green energy.[65] But there is as much cobalt in a single EV battery, for example, as there is in 1,000 iPhones, as much plastic in a single wind turbine as in 5 million iPhones, and as much glass in a solar array that could power a single data center as in 50 million iPhones.[66]

A recent Department of Energy vision for offshore wind (never mind onshore wind farms) in the U.S. would lead to nearly 10 thousand tons of neodymium alone "buried" inside more than 4 million tons of machinery that will eventually head for waste dumps.[67] That sounds like a lot of material worth recovering, but it pencils out to a neodymium concentration in the trash that is one-tenth of the natural ore grade for that mineral at a mine site.[68] Such realities can lead to the surprising outcome that the energy required to recover a recycled mineral can be greater than expended to get it from nature's ore.[69]

That doesn't mean that recycling won't continue to have a role, even a greater one. But its limits are clear. The challenges in meeting the requirements for global minerals in the future will not be met with wishful thinking about "circular economies."

Sources of Minerals: Conflicts and Dependencies

The critical, and even vital, roles of specific minerals have long been a concern of some analysts, and the stuff of fictional dramas as well. One plot in Amazon's *Jack Ryan* series pivots around a secret Venezuelan tantalum mine; in one episode of the Netflix series *House of Cards*, a crisis emerges from a Chinese samarium embargo.[70] The dramas are, of course, animated by real-life dependencies and conflicts over resources, local labor abuses, and gratuitous damage to the local environment.

Today, one can trace a straight line from a medical MRI to giant trucks in the mines of Brazil (for niobium in superconducting magnets),[71] or from an electric car to Inner Mongolia's massive Bayan Obo mines (for rare earths), and from a smartphone to mines in the Democratic Republic of Congo (for cobalt in batteries). Each of those regions represents the world's largest supply of niobium, rare earths, and cobalt, respectively.[72]

Politically troubled Chile has the world's greatest lithium resources, although stable Australia is the world's biggest supplier. Elsewhere in the battery supply chain, Chinese cobalt refiners have quietly gained control over more than 90% of the battery industry's cobalt refining, without which the raw cobalt ore is useless.[73]

The Institute for Sustainable Futures at the University of Technology Sydney, Australia, cautions that a global gold rush for green minerals to meet ambitious plans could take miners into "some remote wilderness areas [that] have maintained high biodiversity because they haven't yet been disturbed."[74] And then there are

the widely reportedly cases of abuse and child labor in mines in the Congo, where 70% of the world's raw cobalt originates.[75]

Late in 2019, Apple, Google, Tesla, Dell, and Microsoft found themselves accused in a lawsuit filed in a U.S. federal court of exploiting child labor in the Congo.[76] Similar connections can be made to labor abuses associated with copper, nickel, or niobium mines around the world.[77] While there is nothing new about such real or alleged abuses, what is new is the rapid growth and enormous prospective demand for tech's minerals and green energy minerals. The Dodd-Frank Act of 2010 includes reporting requirements on trade in "conflict minerals." A recent Government Accountability Office (GAO) report notes that more than a thousand companies filed conflict minerals disclosures with the Securities and Exchange Commission, per Dodd-Frank.[78]

Automakers building electric cars have joined smartphone makers in such pledges for "ethical sourcing" of minerals.[79] Car batteries use far more of "conflict" cobalt.[80] Companies can make pledges; but unfortunately, the facts suggest that there is little correlation between such pledges and the frequency of (claimed) abuses in foreign mines.[81] In addition to moral questions about exporting the environmental and labor challenges of mineral extraction, the strategic challenges of supply chains are a top security concern as well.

Strategic Dependencies: Old Security Worries Reanimated

Supply-chain worries about critical minerals during World War I prompted Congress to establish, in 1922, the Army and Navy Munitions Board to plan for supply procurement, listing 42 strategic and critical materials. This was followed by the Strategic Materials Act of 1939. By World War II, some 15 critical materials had been stockpiled, six of which were released and used during that war. The 1939 act has been revised twice, in 1965 and 1979, and amended in 1993 to specify that the purpose of that act was for national defense only.[82]

As recently as 1990, the U.S. was the world's number-one producer of minerals. It is in seventh place today.[83] More relevant, as the United States Geological Survey (USGS) notes, are strategic dependencies on specific critical minerals. In 1954, the U.S. was 100% dependent on imports for eight minerals.[84] Today, the U.S. is 100% reliant on imports for 17 minerals and depends on imports for over 50% of 29 widely used minerals. China is a significant source for half of those 29 minerals.[85]

The Department of Defense and the Department of Energy (DOE) have issued reports on critical mineral dependencies many times over the decades. In 2010, DOE issued the Critical Materials Strategy; in 2013, DOE formed the Critical Materials Institute, the same year the National Science Foundation launched a critical-materials initiative.[86] In 2018, USGS identified a list of 35 minerals as critical to security of the nation.[87]

But decades of hand-wringing over rising mineral dependencies have yielded no significant changes in domestic policies. The truth is that depending on imports for small quantities of minerals used in vital military technologies can be reasonably addressed by building domestic stockpiles, a solution as ancient as mining itself. However, today's massive domestic and global push for clean-tech energy cannot be addressed with small stockpiles. The options—other than eschewing more green energy—are to simply accept more strategic dependency, or to increase domestic mining.[88]

Green Energy's Radical Acceleration of Strategic Dependencies

The U.S. has in the past half-decade achieved strategic energy independence. This comes after decades of political, economic, and geopolitical anxieties over import dependencies for natural gas and oil, in particular. The nation now produces more gas than it consumes and is thus a net exporter; it also produces 90% of net petroleum needs and is thus essentially strategically independent. As with agricultural products, where the U.S. is also a net exporter, achieving net independence does not obviate a need for or value in imports as part of the overall complex structure of commodity exchanges. But strategic "insulation," as well as geopolitical "soft power," comes from a posture of "dominance" in commodities critical to national survival.[89] While it remains to be seen how much damage is inflicted on domestic energy production in the post-coronavirus recession, it is now clear that the nation has significant capabilities in strategic hydrocarbon production *and* exports. Given that 56% of all America's energy comes from oil and gas, this achievement has deep strategic implications.

On the other hand, as of today, just 4% of overall domestic energy needs are supplied by wind and solar machines, and batteries propel less than 0.5% of domestic road-miles. About 90% of solar panels are imported.[90] Even if the panels were assembled here, the U.S. fabricates only 10% of the global supply of the critical underlying silicon material. China produces half.[91] For wind turbines, the U.S. imports some 80% of the electrical

components (i.e., excluding fiberglass and steel).[92] And while Tesla (accounting for nearly 80% of all domestic EV sales)[93] manufactures domestically, essentially all the critical minerals originate overseas.

Thus, any significant expansion in green machines' tiny share of domestic energy will radically increase imports of either those machines, or the green energy minerals, or both. The quantities of imports will be unprecedented.

The strategic implications of green energy materials have not escaped attention in Europe. An analysis from The Hague Centre for Strategic Studies summarized the "security dimension" of the world's rush to promote renewable energy. The analysis points to three obvious macro trends:

- Mineral-producing countries will gain power.
- Regions with "large unexploited mineral reserves" will gain strategic importance.
- The "gravity of international relations will shift towards countries that possess renewable energy technologies and technical know-how on minerals for renewable energy."

The Hague drily notes that "import dependent countries may use military capabilities to secure mineral resources."[94]

As a consequence, it appears that Europe might embrace policies to encourage more domestic mining, an idea that would have seemed as unlikely a few years ago as the possibility of the EU encouraging more drilling for oil and natural gas. But that is precisely what is being proposed in a "retooling" of the EU's industrial policy.[95] Citing strategic and economic factors, some EU policymakers propose more local mining and refining to meet the mineral needs of green energy. Potential mining projects have been identified in 10 EU countries, including rare earths in Norway, cobalt in Finland, and lithium in Spain and Portugal. It is no small irony that, as the European Investment Bank puts in place policies to stop lending to fossil fuel industries,[96] it is implementing policies to lend to mining projects.[97]

It remains to be seen how Europe's newfound mining ambitions will be greeted by environmentalists and the continent's various green parties, given the hostility of both to extraction industries in general. Just prior to the global coronavirus pandemic, protests started to erupt over plans for new European mines,[98] in response to which industries were spooling up a PR campaign to try to manage "the unfavourable status of mineral extraction."[99]

In any event, environmentalists on both sides of the Atlantic continue to push harder for expanding green energy.[100] How this all plays out in the post-coronavirus world also remains to be seen. But regardless of whether green energy policies are accelerated or slow down, the significant mineral dependencies that already exist will not change unless the U.S. learns to love, or at least make peace with, more mining.

Policies for Supply-Chain Security for Energy Materials: Dig More

Several decades of studies, congressional hearings, and policy analyses have all pointed to the same two facts.[101] One, the territories of the United States contain vast mineral reserves worth trillions of dollars, including every mineral relevant to green energy machines, not to mention those critical for computers and the military.[102] Two, America's share of domestic and global mineral supply continues to shrink.

Similarly, decades of proposals reaching back to the Strategic Materials Act of 1939 have all offered a list of action items that are, each time, essentially identical. And all have included the one central and obvious conclusion: the primary means for decreasing import dependencies is to increase domestic mining.[103] As the National Academies of Sciences pointed out in a 1999 report on mining: "lack of early, consistent cooperation and participation by all the federal, state and local agencies involved in the NEPA process results in excessive costs, delays and inefficiencies."[104]

The U.S. has one of longest permitting processes in the world; investors must navigate a labyrinth of dozens of federal, state, and local rules.[105] It can take one to three decades to get one new mine into production.[106] This compares with a permitting process that typically takes about two years in Canada and Australia.[107] (Permitting in those nations has recently become more arduous.)[108] The U.S., along with Europe, has regulated its way into far greater import dependencies.[109] Less than 10% of global spending on mineral exploration happens on U.S. soil.[110]

At the same time, policymakers and U.S. presidents over the years have radically decreased access to federal lands for mineral exploration, never mind development. In the western states where the federal government controls nearly 90% of the total land area,[111] nearly half that territory is off-limits to mining.[112] In

addition, Congress in 1996 closed down America's epicenter of mining expertise, the Bureau of Mines, laying off most of the staff and distributing those who remained to various other agencies.[113]

Last year, the Trump administration proposed to increase domestic mining.[114] A 2019 Department of Commerce report lists more than 60 recommendations; essentially all of them echo, and are nearly identical to, those made in previous similar reports from both Democratic and Republican administrations.[115] We have decades of nearly identical calls to action.[116] All of it distills to one essential directive: restructure the regulatory environment so that investors can open and operate domestic mines. There is one thing different today: the digital revolution now enables significant, and even radically new, possibilities for more cost-effective and environmentally gentle mineral extraction and production.

Significant advances are still possible in basic materials sciences and chemistry[117]—including techniques for reducing the use of hazardous chemicals needed for mineral refining and in recycling.[118] But, as with the industrial sector in general, it is in software domains where some of the greatest productivity and safety gains will be found.[119] Software and digital technology have finally improved sufficiently to begin offering the kinds of gains in "hard" industries, such as mining and manufacturing, as they have in "soft" industries such as news and entertainment.[120] Mines, for example, have only begun to use automated drills and trucks.[121]

Some intrepid entrepreneurs continue to advance mining development in the U.S., from the huge potential for copper, gold, and molybdenum in Alaska[122] to a rare earth deposit in Round Top, Texas,[123] and (also in Texas) the first non-China facility for refining rare earth ores.[124] The last, a joint venture between Australian, Japanese, and U.S. firms, had a planned start date in 2021.[125]

But in a sign of the times—and an illustration of the failure for green advocates to connect the dots to reality—when it was introduced last year, the administration's proposal to expand domestic mining was met with partisan criticism as "shameful" and harmful to the environment.[126] But in calling for things like stockpiling (specifically for national defense), greater access to federal lands, financial support, and expedited permitting, today's administration is following the same proposals made serially by previous administrations, in both political parties, over many decades.

Indeed, the administration's call to action closely resembles legislation passed into law 40 years ago, on a bipartisan basis, and signed by President Carter. That law, the National Materials and Minerals Policy, Research and Development Act of 1980, specifically called for the coequal pursuit of mineral production and environmental protection.[127]

In order to provide the motivation and the expertise needed to reanimate domestic mining—an action that would provide benefits to all industries dependent on minerals—Congress should update the 1980 mining law. And new legislation should specifically include plans to:

- Resurrect the Bureau of Mines in order to provide an epicenter of expertise, now absent, needed to provide comprehensive, independent domain knowledge on mining technologies.

- Directly link all subsidies and mandates for green energy to policies that support the expansion of domestic mining and minerals refining.

Even without subsidies, mandates, and policies that favor green energy, the future for both America and the rest of the world will see many more wind and solar farms and many more electric cars. That will happen precisely because those technologies have matured enough to play significant roles. And given the magnitude of pent-up global demand for energy and energy-using machines and services—especially after the world struggles out of recession—it is a truth, not a slogan, that the world will need "all of the above" in energy supplies.

These realities, combined with the immutable reality that green machines require extraordinary quantities of energy minerals, can perhaps form a common intersection of interests that support an expansion in domestic mining. That would be, after all, of strategic and economic benefit to the United States, regardless of the debates over whether green energy is a replacement for hydrocarbons, which it is not, or a significant new and valuable energy sector, which it most assuredly is.

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Acknowledgment

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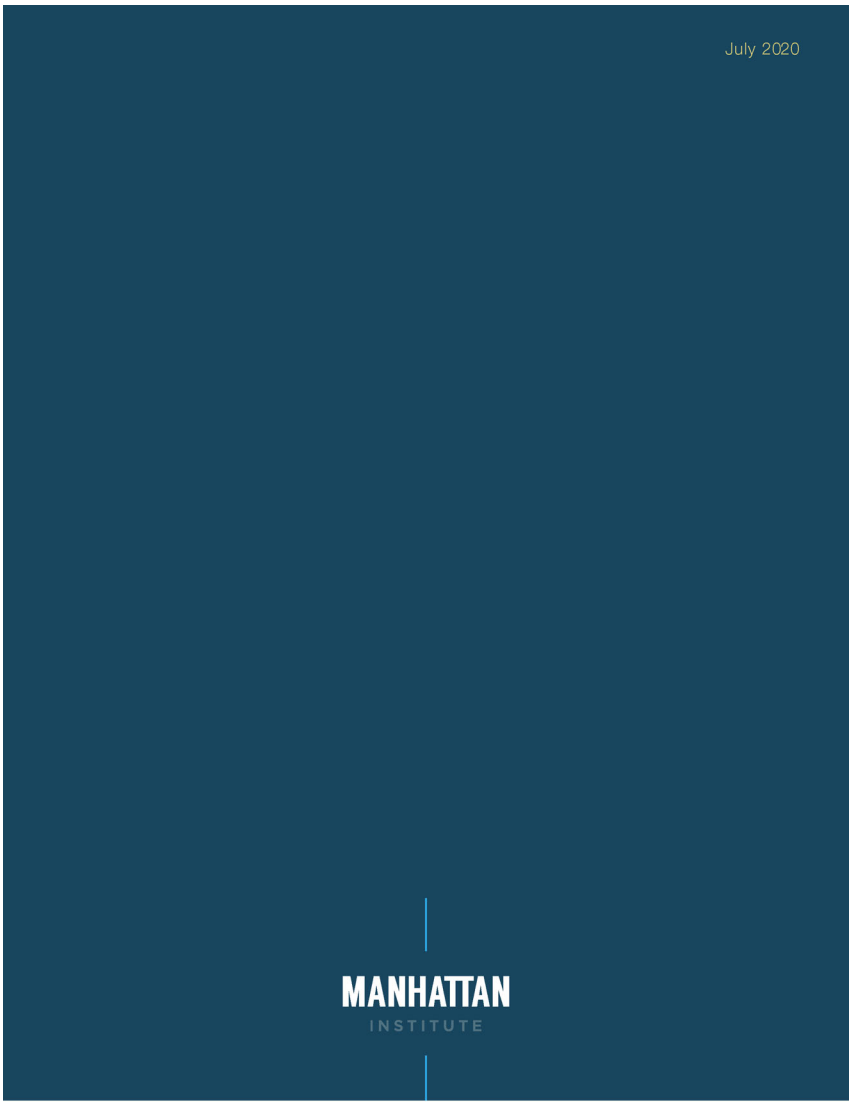
July 2020
MANHATTAN
INSTITUTE

The Secretary of Energy
Washington, DC 20585

October 28, 2021

The Honorable Cathy McMorris Rodgers
Ranking Member
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

Dear Ranking Member McMorris Rodgers:

Thank you for your October 14 letter regarding actions the Administration is taking to ensure affordable and reliable energy for all Americans – a top priority of this Administration and the Department of Energy. We are closely monitoring developments in the oil and natural gas markets.

The United States currently has a natural gas price of approximately $6/MMBtu, while European and Asian markets are seeing prices of $25/MMBtu to $35/MMBtu. Even though we are in a better position than many other countries, the Department's Energy Information Administration (EIA) is predicting higher winter energy bills than last year at this time, when the pandemic had severely curtailed energy demand leading to record low prices for natural gas. The Administration understands that high energy bills can burden household budgets, especially in regions facing higher-than-average prices, and I am working with the President and my colleagues in the Cabinet to identify ways to help families and businesses this winter.

Similarly, in the oil market, the world's recovery from the COVID-19 pandemic is driving up oil prices for both crude and refined products. Crude oil production has not kept up with this increasing demand, and both crude and gasoline prices have increased. The Administration has engaged with other countries to push for greater competition in the global energy market, and the Federal Trade Commission is investigating illegal pricing practices in the domestic gasoline market so that Americans are protected at the pump.

The U.S. government does not manage production levels of natural gas, crude, or refined products. As you know, a significant portion of the world's oil supply is controlled by a small group of countries called OPEC+. This is precisely why the President and I believe that we need to invest in clean energy and reduce our dependence on foreign oil. Further, the Administration does have some emergency tools to address extreme problems with energy supply, and the Department's Office of Cybersecurity, Energy Security and Emergency Response is working across the Department, with other agencies, and with state and regional regulators to actively monitor regional markets and prepare contingency plans. We will be ready to act if the situation warrants it.

Further, the Federal Government can take action to protect families from high heating costs, and President Biden has and will continue to use those tools. For example, the President's American Rescue Plan included $4.5 billion for the Low-Income Home Energy Assistance Program – on top of the annual budget for this program – which last year provided over five million homes with an average of $439 to help with heating costs. The Administration stands ready to work directly with states to get energy assistance funds into the hands of families in need this winter.

Unfortunately, price spikes, supply problems, and reliability challenges are not new to the oil and gas industry. As we saw last winter in Texas, gas infrastructure failed to withstand extreme weather and left families freezing for days[1]. The President and the Administration are working to set the country on a path to reducing our reliance on forms of energy that leave Americans vulnerable to volatile prices and other risks. The current challenging market conditions further highlight the importance of fuel and energy diversity. Decreasing our reliance on price-volatile fossil fuels must be a priority. Investments in energy resources with no or low fuel cost like solar, wind, and nuclear, as well as investments in energy efficiency and electric vehicles will help us reduce our vulnerability to energy price shocks.

A recent analysis showed that achieving a grid with at least three-quarters clean power would help households save $411 to $566 annually on energy expenditures as compared to today.[2] Solar and wind energy are already cheaper than fossil fuels in many parts of the country, and they will continue to get cheaper as deployment expands. By the end of the decade, the Department of Energy is aiming to make solar the cheapest energy source on the planet, while also reducing the cost of long-duration energy storage by 90 percent, allowing wind and solar to serve as baseload, dispatchable power.

The International Energy Agency has reported that the decades ahead will feature challenges that today's global energy system cannot meet – and we must make investments in a more robust, reliable, and sustainable energy system. That means the investments in clean energy and energy efficiency offered in the President's full Build Back Better Agenda are more important than ever. The faster we deploy a wide range of clean energy technologies and sustainability solutions, the better for our energy security, our economy, and the budgets of American families. While the Department of Energy has put billions behind a wide range of clean energy solutions this year, we need Congressional action on both the bipartisan Infrastructure Investment and Jobs Act and the Build Back Better Act to accelerate and scale these efforts. I welcome your partnership.

Sincerely,

Jennifer Granholm

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FRANK PALLONE, JR., NEW JERSEY
CHAIRMAN

CATHY McMORRIS RODGERS, WASHINGTON
RANKING MEMBER

ONE HUNDRED SEVENTEENTH CONGRESS

Congress of the United States
House of Representatives
COMMITTEE ON ENERGY AND COMMERCE
2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6115
Majority (202) 225-2927
Minority (202) 225-3641

October 14, 2021

The Honorable Jennifer Granholm
Secretary of Energy
U.S. Department of Energy
1000 Independence Ave., Southwest
Washington, D.C. 20585

Dear Secretary Granholm:

With winter right around the corner, we have serious concerns about rapidly rising energy prices and the negative impact these price increases are having on the U.S. economy, inflation, and household bills. The Department of Energy (DOE) is tasked with promoting the interests of Americans through the provision of an adequate and reliable supply of energy at the lowest reasonable cost. With predictions of a colder than usual winter this year, we want to understand as soon as possible what actions you and the Department are taking to prepare for what could be a perfect storm of a cold winter, high and unaffordable energy prices, and supply disruptions.

Since President Biden took office, the prices of crude oil and many energy commodities have risen to seven-year highs. Retail gasoline prices have increased 80 percent, natural gas prSices have increased 274 percent, and propane prices have increased 552 percent over the past year-and-a-half.[1] The energy crisis gripping the nation threatens to reverse the progress made under the prior Administration to allow the U.S. to become energy secure. As you know, the U.S. was a net energy exporter in 2019 for the first time since 1952; however, since March our reliance on foreign crude oil imports has skyrocketed.

As Secretary of Energy, your primary responsibility is strengthening and protecting the nation's energy security. Millions of Americans depend on reliable and affordable supplies of these fossil-based fuels for home heating, electricity, transportation, manufacturing, and agriculture. Additionally, as you know, energy price increases are also passed along in many goods and services, stretching family and household budgets, and exacerbating energy poverty.

While we understand that global supply chain disruptions and demand shocks related to the COVID-19 pandemic have influenced domestic prices, we are deeply concerned that the

[1] The U.S. Energy Information Administration reports the weekly average price of regular gasoline has increased from $1.77 per gallon on April 27, 2020 to $3.19 per gallon on October 4, 2021; the price of natural gas has increased from $1.52 per million Btu on June 19, 2020 to $5.68 per million Btu on October 1, 2021; and, the price of propane has increased from $0.23 per gallon on March 27, 2020 to $1.50 per gallon on October 5, 2021.

Administration's anti-fossil fuel agenda is significantly contributing to higher bills for American families and businesses. On his first day in office, President Biden revoked the permit for the Keystone XL pipeline and imposed a moratorium on fossil energy development on Federal lands and waters. In recent comments, you indicated that DOE could respond to high gasoline prices by releasing emergency oil reserves from the Strategic Petroleum Reserve (SPR) or reinstate the ban on crude oil exports that Congress repealed on a bipartisan basis in 2015. These actions and statements, combined with the Administration's goals to increase further environmental regulations and mandate economy-wide net-zero greenhouse gas emissions, have a chilling effect on domestic energy infrastructure investments and supplies.

The pace and trajectory of domestic energy price increases presents serious threats to the health, safety, and welfare of Americans and requires urgent attention. Pursuant to the Department of Energy Organization Act (P.L. 95-91), the Secretary of Energy is required to implement a coordinated national energy policy to address short-, mid- and long-term energy problems. The Secretary is also responsible for the gathering, analysis, and dissemination of energy information to inform policies that could affect energy supply and prices.

In light of your responsibilities, and to assist with our own assessment of the emerging impacts of higher energy prices, we ask that you respond to the following by October 21, 2021:

1) Please describe what specific actions DOE is currently taking, or planning to take in the immediate future, to address energy prices and supply shortages ahead of the upcoming winter.
    a. While the Administration has called on the Organization of the Petroleum Exporting Countries (OPEC) and Russia to boost oil production, what steps is DOE taking to increase U.S. oil production?
    b. In recent comments, you indicated DOE was considering a release from the SPR or imposing a ban on crude oil exports to respond to rising energy prices. Under current law, only the President may authorize these actions in an emergency.[2] Please describe the legal authorities and policy justification supporting DOE's consideration of an SPR release and a crude oil export ban.

2) Please provide DOE's current analysis and projections for residential and commercial electricity and fuel prices for the upcoming winter months.

3) Please provide an assessment of recent Executive Actions, Federal policies, and any regulations that may be causing or contributing to energy price increases.

4) Please provide to the Committee monthly updates forecasting, in six- and twelve-month increments, the best available information on residential energy price trends, rate impacts on low-income households, and DOE actions to mitigate energy price increases. Include in your forecasts:

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[2] The Energy Policy and Conservation Act of 1975 (P.L. 94-163) restricts the drawdown and sale of petroleum products from the SPR unless the President makes an emergency declaration and determines that a severe energy supply interruption exists. The Consolidated Appropriations Act of 2016 (P.L. 114-113) prohibits any official of the Federal Government from imposing a ban on the export of crude oil unless the President declares a national emergency and formally notices the declaration in the Federal Register.

a. Projections using currently enacted policies as a reference case;
b. Impacts on reference case projections by proposed Federal and legislative polices, including international climate commitments submitted by the U.S.; and
c. Actions you are taking to identify and address energy supply and other economic and regulatory factors affecting the price trends.

You may have your staff work with Mary Martin or Brandon Mooney of the Republican Committee staff on the details of this request. We appreciate your prompt attention to this urgent matter.

Sincerely,

Cathy McMorris Rodgers
Republican Leader
Committee on Energy and Commerce

Fred Upton
Republican Leader
Subcommittee on Energy

Robert E. Latta
Republican Leader
Subcommittee on Communications and Technology

Brett Guthrie
Republican Leader
Subcommittee on Health

David B. McKinley
Republican Leader
Subcommittee on Environment and Climate Change

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Republican Leader
Subcommittee on Oversight and Investigations

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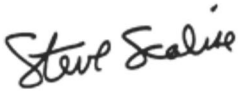
and Commerce

Michael C. Burgess, M.D.
Member of Congress



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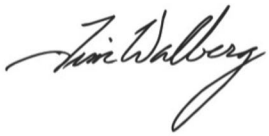

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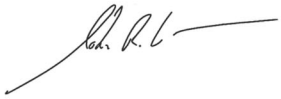

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U.K. Power Prices Soar Above £2,000 on Low Winds

finance.yahoo.com/news/u-k-power-prices-soar-184846825.html

Jesper Starn and Rachel Morison

(Bloomberg) -- Some coal and gas power stations in Britain were paid double the price of exchange-traded electricity to help plug a gap left by a drop in wind generation on Monday.

Two coal-fired units at Uniper SE's Ratcliffe station got more than 3,200 pounds ($4,295) a megawatt-hour while four gas units received 3,500 pounds. Intraday power in the U.K. soared to 1,500 pounds for the half-hour to 6:30 p.m. on the Epex Spot exchange, with wind-power generation falling to the lowest level in 56 days. Prices for Monday were almost double the average day-ahead rate for this year.

Britain is set to end the use of coal within three years and make power generation free of fossil fuel by 2035. But for now it falls back on high-emission coal when wind drops or demand increases. Wind generation on Monday was meeting just 6% of total demand, National Grid data show, while gas contributed 55% and coal 2%.

It's Finally Getting Cold and Europe Doesn't Have Enough Gas

U.K. gas prices are more than three times higher than at the start of the year, as imports from Russia to Europe slowed, and periods with low wind will only increase dependence on the fuel. In the day-ahead power auction, the hourly contract rose to the second-highest on record while the average price for Monday was the highest since Sept. 14.

A strained power situation in the rest of Europe is also limiting export capacity to the U.K. French day-ahead power prices rose as a strike lowered output on Monday, while prices in Germany increased to the highest level since Oct. 6.

The strike has cut output from Electricite de France SA's generation fleet by about 2 gigawatts. That will reduce the amount of supply that can be exported to Britain along two key interconnectors. A limit on flows through the North Sea Link, that has been reduced to half capacity since Oct. 1, was extended to Thursday. The fault has delayed a ramp up to 1,050 megawatt that was planned for later this week.

The supply situation is expected to ease by Tuesday with U.K. prices dropping to 175 pounds a megawatt-hour as wind generation resumes.

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Center for American Progress

Creating a Domestic U.S. Supply Chain for Clean Energy Technology

By Mike Williams and Trevor Sutton October 4, 2021

The global clean energy industry is at an inflection point. The trajectory of generating and deploying clean energy has risen[1] globally, in spite of the COVID-19 pandemic. Political and consumer support[2] for clean energy remains high, and costs are dropping.[3] In addition, the United States is poised to make historic investments in clean technology deployment in order to meet its international climate commitments and cut the nation's emissions by 50 percent by 2035.

The amount of materials and products needed to supply this growth in production will increase exponentially over the next few years. That raises the question: Will these materials and products come primarily from abroad, or will they be sourced and manufactured in the United States? From lithium in electric vehicle (EV) batteries, to the steel in a wind turbine, to the polysilicon in a solar panel, the next decade represents the best opportunity to date to onshore the manufacturing supply chains of clean technology. In doing so, this country would create and retain[4] tens of thousands, and potentially hundreds of thousands, of good jobs for working Americans.

This issue brief examines one set of proposed policies that will help build domestic renewable energy supply chains: investment tax credits for renewable energy facilities that use domestically made or domestically sourced goods. Such domestic content provisions can be found in the Clean Energy for America Act[5] proposed and moved by the Senate Finance Committee as well as comparable provisions[6] in the House Ways and Means Committee's contributions to the Build Back Better legislation—the effort by Congress to put into law President Joe Biden's agenda of creating jobs and lowering costs for working families. This brief explains why such provisions should be included in clean energy legislation considered by Congress, arguing that domestic content tax credits will create good jobs for working Americans, help fight the climate crisis, and strengthen U.S. national and economic security.

Background

Federal support to American industry through domestic content requirements has a long history. The Buy American Act of 1933[7] (BAA) instructed federal agencies and contractors to buy U.S.-manufactured end products and construction materials on contracts valued above a certain threshold. The BAA's requirements can now be waived at the discretion of the president in order to comply with international treaty obligations—for example, commitments to afford foreign goods the same treatment as domestic ones. Such waivers became substantially harder to obtain under the Trump administration, which ordered[8] federal agencies to make efforts to ensure contractors are not using so-called dumped goods—that is, foreign goods sold at a lower price than in their domestic market. For its part, the Biden administration is seeking to ensure that federal procurement supports American workers and businesses through a Buy American rule[9] proposed in July.

The Clean Energy for America Act—and comparable provisions in the House Ways and Means Committee's provisions—represents a new approach to domestic content requirements. Under the act, investments in renewable energy facilities—those producing zero greenhouse gas (GHG) emissions—put in service starting in 2023, or electric grid improvement properties, will receive a 30 percent tax credit relative to the value of the investment. For certain facilities in disadvantaged communities, the credit increases to 40 percent. In cases where the taxpaying entity lacks sufficient revenue to benefit from these tax credits, it can receive a direct, or cash, payment from the government equal to the amount of the tax credit. These provisions would substantially enhance some existing tax credits for investments in renewable energy and make permanent others that are set to expire.

The proposed domestic content credit under the act would increase the renewable energy tax credit available to all investments by 10 percent where the facility in question is composed of domestically made steel or iron and/or manufactured products. In the case of manufactured products, "domestically made" means that at least 55 percent of the total cost of the components of the product can be attributed to domestically produced items.[10] Additionally, a clean electricity project will eventually lose the opportunity to receive a direct payment in lieu of a tax credit if the project fails to meet domestic content requirements.

The domestic content credit is novel in two ways: First, it encourages onshoring of supply chains through the tax code, rather than through public procurement requirements, and second, it extends the incentive to buy American to private sector actors, unlike the BAA, which applies only to federal agencies and their contractors. By guiding private markets, this tax credit has the potential to move the renewable energy sector toward domestic supply chains in a manner that was previously possible only for industries that depended heavily on federal contracts, such as aerospace and defense.

Building a domestic supply chain for renewable energy: It's now or never

These domestic content provisions come at a crucial juncture for the renewable energy industry and its suppliers. Today, renewable energy accounts for barely more than one-tenth[11] of total energy generation and consumption in the United States. The Biden administration has set a target[12] of 80 percent clean power by 2030 and a fully carbon-free electricity grid by 2035. While achieving those targets will depend on many factors—most crucially, the fate of climate legislation in Congress—there is no question that the U.S. renewable energy sector is poised for a massive expansion in the coming decade. This growth in renewables will require a comparable growth in the supply of both finished and component goods to support the construction of new facilities and the upgrading of existing ones.

Currently, the U.S. renewables sector is highly dependent on foreign supply chains. Chinese exports dominate[13] the supply of solar panels used in both commercial and private energy generation, owing in large part to years of Chinese subsidies; funding for research and development; and what the United States and European Union have characterized as prohibited dumping[14] practices. In the case of offshore wind, meanwhile, both the industry and, by extension, the U.S. supply chain are "immature"[15] to the point of being nonexistent; however, there is significant domestic industrial capacity to support manufacturing offshore wind turbines and their component parts as more offshore wind projects come online in the next decade.

While the prospect of rapid growth in renewable energy presents an opportunity for domestic suppliers to meet rising demand, that outcome should not be assumed; the experience of other industries—for example, semiconductors—reflects that a growing domestic market does not translate into more onshore production and jobs. This means that the next decade presents a critical window for American industry to support a massive expansion in U.S. renewable infrastructure—one that will likely never recur. The supply chain relationships that develop during the coming renewables boom will likely define the industry for the foreseeable future. If U.S. manufacturers of solar panels, wind turbines, and utility-scale batteries—as well as the inputs used in the production of these technologies, such as steel and aluminum—are not able to secure a favored, or at least competitive, place in those supply chains, their commercial outlook will be substantially impaired. It is not inconceivable that the renewable industry could follow the path of semiconductors[16] and consumer electronics, in which engineering and design occurs in the United States, but most production occurs overseas with foreign components.

The tax credits connected to domestic content—alongside direct investments in industry such as the 48C credit[17]—provided in clean energy tax legislation currently moving through the Senate and House of Representatives can help domestic industry meet this challenge. More than a decade of focused industrial policy vaulted Chinese solar manufacturing into a position of global dominance.[18] If the United States hopes to compete in this and other renewable sectors globally, it will need to show a similar focus and commitment to supporting industry during critical growth periods.

All of this raises the question: From a public policy perspective, why should the United States seek to ensure that renewable energy supply chains are manufactured domestically? This issue brief sets out three key reasons below.

1. Domestic manufacturing will create good jobs and contribute to a revitalized middle class

Plainly stated, manufacturing is a boon to the economy. It supports local communities and often provides quality, middle-class livelihoods for working people. According to the Economic Policy Institute,[19] manufacturing workers—who make up more than 11 million people in the U.S. workforce—earn 13 percent more in hourly compensation than comparable workers in other industries, and they have an advantage in health care and retirement benefits.

Manufacturing's impacts on the broader economy are foundational and yet often understated.[20] The act of producing a good has a long stream of value, from the processing of the raw materials through the production process and then into the downstream sales. Analysis[21] that considers the value from inputs not including downstream output shows that manufacturing accounts for more than 11 percent of the U.S. gross domestic product (GDP), including a total output of more than $2.3 billion in 2018. Research[22] shows that these numbers may be lower than the reality, as they underestimate the "multiplier effect"—which shows the impact on other industries from economic activity in manufacturing—notably by excluding the downstream impact. The MAPI research shows that manufacturing accounts for roughly one-third of U.S. GDP when considering the full value stream impact

Now consider this in less technical terms by envisioning a hypothetical situation. An EV is manufactured in America—say, for example, in Michigan. Thinking about the upstream value, its frame is made with steel melted and poured in Pennsylvania and comes from iron ore mined in Minnesota. Its battery is assembled in Georgia and includes lithium that comes from California. Those materials, and many more, need to be produced and refined in their own manner and then transported to the point of assembly. Once assembled, the EV itself is then transported to dealerships across the country. At every point in this hypothetical journey, there would be real communities with real people who benefit from these jobs.

2. Locating manufacturing supply chains in the United States meets the country's climate and justice goals

Manufacturing's environmental and societal impacts are not uniform. A good can be produced utilizing a workforce with full rights and decent pay, or it can come from the hands of a workforce subject to dangerous workplace conditions and low pay relative to local cost of living, or even forced labor. A good can be produced in a facility with efficient and advanced pollution controls—even with minimal to no pollution—or it can emerge from a facility that degrades the local and global environment.

Starting with the climate impact, manufacturing is responsible for roughly one-third[23] of global GHG emissions. Iron and steel alone make up 11 percent[24] of global emissions, and cement produces 4.5 percent[25] of emissions. China accounts for more than half[26] of the world's steel production, and it manufactures steel with upward of twice[27] the emissions intensity on average that is produced in the United States. With regard to vehicles, the United States is a net importer[28] of embodied emissions—the emissions associated with a good's production—across multiple sectors of vehicles, ranging from two to four times more emissions in the goods this country imports than those that are domestically produced.

The situation with human rights is perhaps even bleaker. The solar industry is working to realign its global supply chains to avoid the provinces of China where there are allegations of forced labor.[29] The minerals that go into many clean energy products, most notably batteries, currently come from mining processes that have been particularly harsh to the miners and the communities where the mines are located. Cobalt is an egregious example, where there is an ongoing lawsuit[30] alleging the use of child labor. The mining of lithium and copper in Chile has contributed to the desolation[31] of the Atacama Desert.

Sourcing critical minerals from countries with poor human rights and environmental records is effectively streamlining this part of the supply chain in a manner that places profits over the human impacts. Similarly, as this supply chain grows in the United States, it is critical that strong safeguards for working people, their communities, and the environment are in place. A recent report[32] from a coalition of environmental and conservation organizations phrased it well: "This requires smart planning, stakeholder collaboration and careful execution. History provides a powerful lesson on what happens when those attributes are absent."

The United States needs batteries, steel, and cement to produce the clean energy products that will drive its emissions to zero. How America chooses to produce these materials is not forced on it. The country can produce these goods with minimal impact on the environment and with a workforce treated with decency and respect. America's best hope to achieve this is by controlling its own destiny and producing materials domestically. Then, using this example, the country needs to establish a significantly more just trade regime that lifts up workers and protects the environment.

3. Sourcing supply chains domestically is critical to ensuring national and economic security

Last but not least, promoting the onshoring of renewable energy supply chains would carry significant national security benefits to the United States. The COVID-19 pandemic has laid bare the substantial risks to the health and well-being of U.S. citizens posed by "just-in-time"[33] supply chains—that is, supply chains designed to deliver only enough inventory to meet anticipated market demand, and no more—in areas such as personal protective equipment, medicine, and even basic hygiene and sanitation supplies. These supply chains, while carrying cost advantages to industries during ordinary times, proved fragile and unreliable in a period of economic and political crisis.

U.S. policymakers are currently examining[34] the threat of supply chain fragility across a range of industries that are viewed as strategically sensitive to U.S. interests—most prominently, semiconductors—with a view toward building redundancy and resilience in the supply of critical goods. The purpose of such efforts is to ensure that future disruptions do not deprive the U.S. government and ordinary Americans of goods that are vital to their safety, security, and comfort. Such future disruptions could include not only natural disasters, such as another pandemic, but also those arising from geopolitical tensions. As illustrated by Russia's energy politics in Eastern Europe,[35] a supply chain that is concentrated in the territory of a geopolitical adversary makes the United States and its consumers vulnerable to retaliation and extortion by a foreign government.

There is a compelling argument for treating resilient renewable energy supply chains as a critical national security issue. Energy security has long been a national security priority of the United States and most other countries. During the past decade, the United States has substantially increased its domestic energy base, but it has done so primarily through innovations in hydraulic fracking that have increased the availability of natural gas and oil. Renewable energy offers the country a way of sustaining—and eventually increasing—its energy security in a way that does not contradict its climate goals. This sector also does not subject communities to the rapacious cycle of extraction and abandonment that characterizes the boom-and-bust world of fracking.

But achieving energy security through a pivot to renewables is only possible if the products and components used to generate solar, wind, and other forms of clean energy are reliably available to operators of energy grids. And that, in turn, requires onshore supply chains with substantial capacity to make up for disruptions in global trade, whether natural or resulting from geopolitics or armed conflict. If renewable energy supply chains remain concentrated in foreign jurisdictions—especially in those with authoritarian governments, whose values and interests are often antagonistic to those of the United States and its democratic allies—policymakers will face an unenviable choice between greening the U.S. energy base and exposing the U.S. economy to foreign influence and coercion.

America should demand that public funds used to support an industry maximize public good

The summary of these three arguments can be boiled down to this: When public funds are used to support an industry, that money should prioritize the public good. Good jobs, a clean environment, and energy and national security meet the vision laid out in President Biden's Build Back Better agenda.

Americans should not ignore that this effort may require time to invest in domestic facilities in order to build up capacity. This type of retooling and new investment is not unique, however; there are many examples[36] of companies meeting the moment of the coronavirus crisis and rapidly switching their production to produce personal protective equipment. The Manufacturing Extension Partnership[37] exists to help manufacturers achieve exactly this, and there is a significant level of funding included in the proposed Build Back Better legislation[38] to support the resilience, diversity, and strength of domestic supply chains.

Conclusion

The level of investment in clean energy deployment, paired with direct investments and domestic content requirements in the Build Back Better legislation, creates a clear path for manufacturers to take on a large portion of the clean energy supply chain. This is America's moment to act.

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Attachment—Additional Questions for the Record

Subcommittee on Environment and Climate Change and Subcommittee on Energy
Joint Hearing on
"Securing America's Future: Supply Chain Solutions for a Clean Energy Economy"
November 16, 2021

Ms. Roxanne Brown, International Vice President at Large, United Steelworkers

The Honorable Diana DeGette (D-CO)

The Solar Energy Industries Association (SEIA) has developed a Supply Chain Traceability Protocol under which suppliers:

1. Identify the source of a product's material inputs,
2. Trace the movement of these inputs throughout the supply chain, and
3. Submit to a third-party audit of this information.

U.S. Customs and Border Protection (CBP) has reportedly adopted elements of this Protocol in its review of imported products and materials.

If you are familiar with either the SEIA Protocol or CBP actions, please respond with regard to them. If not, please respond regarding the general concepts mentioned here.

1. What do you think of requiring importers of products, for example, solar modules, to identify the sources of their products' material inputs?

   RESPONSE: The USW has long supported better traceability in supply chains for labor, environmental, and consumer protections. Requiring importers of products to identify the sources of their products' material inputs will improve consumer awareness of products and allow regulators to meet a nation's economic, humanitarian, and security goals.

   Recent work by the Government of Canada to improve tracing in the steel industry supply chain has been reviewed in the Organization of Economic Cooperation and Development (OECD) has shown that recent advances in data can improve data collection of products material inputs.[1]

[1] OECD

2. What do you think of requiring importers to trace the movement of these inputs throughout the supply chain?

   RESPONSE: The USW sees corporate responsibility as an important component in tracing movement of inputs throughout the supply chain, so long as it is easily accessible for government agencies as well. Important to preventing globally condemned forced labor tactics or consumer safety – improved tracing of inputs in supply chains should be as easy as a Google Search.

   As an example, the Takata airbag scandal, which saw the largest recall in automotive history, occurred in part because of poor and inadequately kept records. This inability to properly trace products that were primarily sourced from a Mexican subsidiary forced the recall of over 50 million vehicles – costing lives and OEM's significant resources.

3. What do you think of submitting this kind of information to a third-party audit by a private entity?

   RESPONSE: The ability of firms to audit their supply chains through third-party audits has had mixed results and has yet to stamp out forced labor and other abuses of labor & environmental laws by major corporations.

   For example, in 2019 the Clean Clothes Campaign, which is the garment industries largest alliance of labor unions and non-governmental organizations, issued a report called "Fig Leaf for Fashion", which highlighted how voluntary and unilaterally defined system of corporate social responsibility (CSR) policies do not provide transparency or remediate worker violations in apparel supply chains.[2]

4. What do you think of submitting this kind of information to CBP?

   RESPONSE: The ability to hold firms accountable for their global supply chains requires a strong government position to defend American workers and consumers from labor and environmental abuses in the supply chain. Requiring this data collection at CBP could be one avenue to reaching that goal.

   It is also helpful to think about data currently submitted by firms to the federal government. For example, respondents in anti-dumping and countervailing duty investigations receive significant questionnaires from the Department of Commerce, which allows the agency to calculate dumping and countervailing duty margins. This data includes information on inputs, energy prices, alleged subsidies, sale prices, etc.

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[2] Clean Clothes

The Department of Commerce also regularly instructs CBP to collect duties on firms that try and circumvent existing anti-dumping and countervailing duty orders. This requires a level of traceability that the federal government can, and should, aspire to for all products – particularly for firms that choose to operate in locations with low labor, human rights, and environmental regulation.

5. Do you think the tracking and disclosure of this kind of information can be done credibly without subjecting it to review by CBP for compliance?

   RESPONSE: As indicated above in the previous question, CBP may not necessarily be the agency for this sort of tracking and disclosure work. The Department of Commerce also does significant research on imports of goods and this agency may actually be better situated to analyze data for tracking and disclosure of supply chains.

   However, the union is severely skeptical of tracking and disclosure of this kind of information without subjecting the information for federal review.

6. Are there other measures you would suggest for identifying the sources of the materials and components used to manufacture imports or for otherwise inhibiting or preventing the production and manufacture of materials and products from entities or regions that do not uphold the same high labor and environmental standards as the United States?

   RESPONSE: The USW supported the renegotiated NAFTA deal – USMCA – in part because the trade agreement incorporated a Rapid Response Mechanism, which creates a process at a firm level to remedy labor violations in Mexico. Also, failure to find a remedy could lead to significant penalty.

The Honorable Kathy Castor (D-FL)

1. We often think about jobs installing wind and solar as the climate jobs of the future, but the fact is there are so many more jobs that are climate jobs. The jobs created by investing in the robust domestic supply chains for the clean energy materials and technologies will employ Americans across the country.

   How can we work with labor unions to ensure that Americans are trained and ready for these new climate jobs in domestic clean energy supply chains and a circular economy?

   RESPONSE: I agree that manufacturing jobs in the clean energy supply chain are also climate jobs of the future and the present. Manufacturing unions and manufacturing workers are eager to work with Congress on making sure that we

can make the materials and products for clean energy here in the United States. There are four things that would be immediately helpful:
1. Work with new and existing companies and unions to identify and fund opportunities to retrofit, retool, and serve new markets.
2. Ensure that manufacturers have long-term markets for products by supporting domestic content standards for clean energy.
3. Ensure that existing workers and prospective workers are properly trained by expanding vocational education and incentivizing labor-management training programs.
4. Ensure that clean energy jobs are good jobs by passing the PRO Act to modernize our labor laws and ensure that all workers can join a union without fear of retaliation.

2. In your testimony, you note the need for industrial policy to drive innovation and investment in manufacturing industries. An expanding clean energy industry in America is helping us tackle the climate crisis, but we need to make sure manufacturers have the tools they need to decarbonize their factories while they meet increasing demand. This past summer, I introduced the First Three Act that would drive transformative technology adoption in manufacturing industries to decouple our industrial processes from volatile fossil fuel prices and their carbon emissions.

   Do you see a role for transformative federal investments in low- and zero-emission technologies in manufacturing industries like steel?

   RESPONSE: There is, without question, a role for transformative federal investments in decarbonizing the industrial sector with technologies like carbon capture, direct air capture, hydrogen, and more. These technologies are not currently widely available, so federal investment and partnership will be key to assisting U.S. industry in assessing, installing, and financing low- and zero-emission technologies. These types of investments will ensure that our domestic industry is globally competitive long-term as markets shift to demand more low-emission materials.

3. Expanding domestic supply chains for clean energy technologies could mean an increase in good-paying, family sustaining jobs, like those in the Tampa Shipyard. Could you expand on what rapidly growing clean energy industries like offshore wind could mean for supply chain jobs all across America?

RESPONSE: If done right, offshore wind could mean economic benefits in communities across the country, not just at the coasts. There are, of course, the white collar, engineering, and construction jobs that are widely touted. However, there is so much potential in the supply chain to support this industry. For the turbines themselves, developers will need steel; cement; blades of carbon fiber; coatings and paints; bearings; cables; ladders; platforms; and more. On top of that, workers in the United States need to build the ships to install offshore wind projects. There are workers in communities across the country who can supply these materials.

a. How do we ensure we will see the benefits we anticipate?

RESPONSE: There are several important actions that can be taken to ensure that these are good jobs:
1. Congress should use policy and funding levers to maximize domestic content to provide job certainty.
2. The federal government should assess supply chain gaps and opportunities, and communicate that information to unions and companies across the country. And companies should receive assistance, as needed, to help retool facilities to fill those supply chain gaps.
3. Incentivize and facilitate partnerships between unions and offshore wind developers and original equipment manufacturers (OEMs).
4. Ensure consistent enforcement of the Jones Act.
5. Pass the PRO Act.

The Honorable Dan Crenshaw (R-TX)

1. According to the letter sent to me by the Communications Infrastructure Contractors Association, "the cost of steel for manufacturing communications towers is up sharply; the cost for 2" galvanized antenna pipe has soared by 80% in just the past year, and steel mounts that used to ship within 2-3 days are now taking 6-8 weeks to ship. Electrical wire prices were predictable one year ago, while today they are adjusted daily. Two-inch PVC pipe has gone from $5.61 to $24.26 each within one year and 4" PVC pipe has gone from $14.37 to $45.66 each within the past year. Concrete prices are up 30%."

   How have these increases in prices impacted employment by your members and their associated domestic manufacturing?

RESPONSE: The COVID-19 pandemic has dramatically disrupted supply chains globally, including both the steel and plastics sectors. For example, steel prices have increased in the U.S., but they have also increased globally.[3]

This has created opportunities and challenges, but broadly manufacturing employment in the United States has increased by 349,000 jobs in 2021. Holding firms accountable to possible price gouging is possible, but would require congressional action to look into private company financials and to set it off a baseline of previous earnings. Given that corporate profits for S&P 500 companies rose 22 percent in the 4th quarter and nearly 50 percent in 2021 – the USW would encourage Congress to carefully consider all factors of increased pricing.

2. Additionally, the letter goes on to state "delays in our ability to obtain trucks and other heavy equipment critical are unquestionably inhibiting work on communications infrastructure. Lead times for new crew trucks are out as far as 9-12 months, and surging prices will further harm our economic viability. The prices for used trucks (if they are even available) are up sharply as well."

   President Biden's Build Back Better agenda includes funding for states to implement zero-emissions vehicles requirements, like the one done by CARB, in California. How have zero-emissions vehicles requirements contributed to the supply chain crisis that is currently happening?

   RESPONSE: The problems you describe are not linked to zero-emission vehicle requirements and are instead a supply chain problem for semiconductor chips. Automakers around the world are citing shortages in semiconductor chips necessary for building new vehicles. This has slowed assembly of vehicles and manufacturing of parts, causing increased prices and shortages of vehicles. The CHIPS Act, which passed last year as part of NDAA, is an important piece of legislation to ease this supply chain crisis; however, it must be funded. The Senate passed funding for the CHIPS Act in USICA, but the House has not yet acted.

3. Later in the letter, it states "Certain heavy civil equipment, such as excavators and forklifts, also have long lead times, and prices are also outpacing inflation. Additionally, the availability of chipsets, necessary for wireless equipment, and other essential technological components, such as fiber optic cabling, have also been severely compromised."

   How is the Build Back Better agenda making it easier to site and permit the processes needed to create resins and steel in the United States?

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[3] OECD See: page 26

RESPONSE: Our union represents U.S. workers at Corning in Wilmington, NC who make fiber optic cable, which is critical for the build out of broadband to rural areas and other technologies. These workers have immense opportunities to supply the materials needed for American infrastructure and the spending on broadband that Congress authorized in the Infrastructure Investment and Jobs Act. Unfortunately, the Build Back Better Act has not yet become law, so workers across the country cannot yet benefit from the investments in communities and workplaces, as outlined in the bill.

Attachment—Additional Questions for the Record

Subcommittee on Environment and Climate Change and Subcommittee on Energy
Joint Hearing on
"Securing America's Future: Supply Chain Solutions for a Clean Energy Economy"
November 16, 2021

Mr. Lucian Pugliaresi, President, Energy Policy Research Foundation, Inc. (EPRINC)

The Honorable Diana DeGette (D-CO)

The Solar Energy Industries Association (SEIA) has developed a Supply Chain Traceability Protocol under which suppliers:

1. Identify the source of a product's material inputs,
2. Trace the movement of these inputs throughout the supply chain, and
3. Submit to a third-party audit of this information.

U.S. Customs and Border Protection (CBP) has reportedly adopted elements of this Protocol in its review of imported products and materials.

If you are familiar with either the SEIA Protocol or CBP actions, please respond with regard to them. If not, please respond regarding the general concepts mentioned here.

1. What do you think of requiring importers of products, for example, solar modules, to identify the sources of their products' material inputs?

   RESPONSE:
   Additional requirements for importers to identify their products' material sources will likely facilitate the U.S. government's actions against forced labor and human rights violations in countries like China while providing American solar module buyers with greater transparency. This requirement, either through the SEIA Protocol or the CBP actions, may yield other positive results such as quantifying the U.S. energy vulnerability to foreign supplies as well as bringing light to the high levels of greenhouse gas emissions from production of clean energy technologies in coal-dependent regions.

   This requirement may also pose challenges and shortcomings that outweigh its potential benefits. First, it is dubious that accurate and reliable data can be collected in parts of the world that do not uphold the same high U.S. standards, which defeats

the very purpose of such a requirement. For example, China is known for its poor data quality, and therefore, it might be difficult for U.S. companies to effectively collect sensitive information reliably regarding both the sources and movements of material inputs from their suppliers in that country. Second, such a requirement presents uncertain trade implications. Without a careful, phased approach, the requirement and any resulting changes from it could harm the United States financially. Possible costs include increased trade tensions with China over goods not limited to solar modules, price fluctuations of importing products, and reciprocal measures from trading partners on U.S. export products, including the EU-proposed Carbon Border Adjustment Mechanism (CBAM) that may cause a reduction in U.S. liquefied natural gas exports to Europe.

2. What do you think of requiring importers to trace the movement of these inputs throughout the supply chain?

RESPONSE
Tracing import products' material inputs throughout the supply chain has its benefits in addressing forced labor. As in the first question, however, doing so is an enormously challenging task due to the poor quality of data in other countries as well as potential implications for international trade. The process can get further complicated technically and politically as the full participation of all countries throughout the supply chain is necessary for an effective implementation. For maximum effectiveness, foreign suppliers should be required or encouraged by their governments to share their sensitive information with the CBM through their U.S. import partners. Additionally, there may arise technological challenges since data collecting methods, e.g., using smart sensors or blockchain technologies, are nonuniform across different regions and sectors. Other potential drawbacks are discussed in my answer to Question 1.

3. What do you think of submitting this kind of information to a third-party audit by a private entity?

RESPONSE:
An independent, third-party audit is important to monitoring and verifying the conformity of an importer's activity against the requirement's criteria. Submitting sensitive information to a private entity auditor should not be of a concern so long as the third-party organization, per the SEIA Protocol, is qualified and independent of the customer-supplier relationship and handles sensitive information under non-disclosure agreements. However, the main problem with the procedure defined by the Protocol is that all information collection and verification activities happen solely between the importer and the auditor in the United States, without any direct audit or verification outside the country. Unless the auditor has a strong, effective presence in a foreign country or countries of interest or at least years of experience monitoring and verifying industrial data from those countries, a third-party audit is simply a review of the documentation presented by the importer. Further, I think it is inadequate to require by the Protocol that relevant information be collect by

"appropriate sampling and should be verified as far as practicable." Instead, the Protocol should provide a uniform, yet more detailed, set of process steps and criteria to minimize confusion and save the importers' time and money.

4. What do you think of submitting this kind of information to CBP?

RESPONSE:
The importer should share this kind of information (the sources of material inputs and movements throughout the supply chain) with CBP in accordance with U.S. laws. According to U.S. CBP's *Reasonable Care: An Informed Compliance Publication*: "Under Section 484 of the Tariff Act, as amended (19 U.S.C. § 1484), the importer of record is responsible for using reasonable care to enter, classify and determine the value of imported merchandise and to provide any other information necessary to enable CBP to properly assess duties, collect accurate statistics, and determine whether other applicable legal requirements, if any, have been met."

5. Do you think the tracking and disclosure of this kind of information can be done credibly without subjecting it to review by CBP for compliance?

RESPONSE:
I have no definite stance on this question, but given the reasons I mentioned regarding a third-party audit an additional review by CBP might be necessary to undertake tracking and disclosure more credibly.

6. Are there other measures you would suggest for identifying the sources of the materials and components used to manufacture imports or for otherwise inhibiting or preventing the production and manufacture of materials and products from entities or regions that do not uphold the same high labor and environmental standards as the United States?

RESPONSE:
There is no quick fix to this issue due to the challenges of accurately identifying the sources of material inputs and supply chain movements. As such, it might be more impactful to mobilize domestic demand at home than precisely identifying which specific region or company violates human rights abroad. A shifting demand can start from placing a greater focus on promoting the public awareness and understanding of the actual labor and environmental conditions of countries from which solar and other energy materials are imported and of the carbon intensities of imported clean energy technologies.

The Honorable Fred Upton (R-MI)

1. A forced energy transition driven by government regulations and mandates for economy-wide net-zero greenhouse gas emissions would require a massive transformation of the world energy complex. Can you provide some additional information on the scale of difficulties relating to net-zero or carbon free energy by 2050?

RESPONSE:
The fundamental problem and risks with a forced energy transition is that the cost and functionality of alternative fuels and carbon capture systems remain too high. Four pillars of modern civilization, steel, cement, ammonia (fertilizer), and plastics have no cost-effective substitute at scale. Cost is the primary constraint and regions of the world facing large population growth and requirements to lift living standards will not be able to absorb such costs and nor will there be any political consensus to accept reduced living standards to achieve so-called "net-zero" goals. Population growth, rising incomes, and economic fundamentals in the non-OECD nations will determine the future of the energy transition. EPRINC tested a "net zero" scenario in which all OECD countries approach net zero emissions. Although such an outcome is unlikely, it would have only a modest effect on global greenhouse gas (GHG) emissions. Total reduction in GHG emissions would be limited to approximately 20 percent of total emissions in 2050. Even if such an accomplishment were realized, more than half of global final energy consumption would come from fossil fuels in 2050.

There will be some progress in scaling new and lower carbon fuels and technologies. Some key technologies—electric vehicles, carbon capture and storage, and low-carbon hydrogen—will make important contributions to future energy systems, but these contributions will largely take place in the developed world. Rising energy demand from population and income growth in the developing world will offset the value of the carbon emission limits achieved in the OECD.

In the developing world, fossil fuels will maintain its dominance in final consumption and petroleum will continue to meet growing demand in the transportation sector of emerging economies, while residential and commercial buildings will use more natural gas displacing coal use for heating and cooking. There will be improved efficiencies and progress in limiting GHG emissions and, but the world in 2050 will look much more like 2020 than the aspirational goals set by IEA or the Paris Accords.

Federal and state policies to accelerate the energy transition pose several risks to the United States and her allies in the medium- to long-term. Acceleration of alternative fuels and technologies could substitute U.S. reliance on petroleum as an energy source (a fuel in which the United States is largely self-sufficient) for greater reliance on less secure worldwide supply chains of critical minerals for newer low-carbon technologies. If newer lower carbon emitting technologies are deployed, energy resilience will likely decline rapidly. Electricity generation has not yet fully adapted to the use of large supplies of power from intermittent renewable energy. Only when

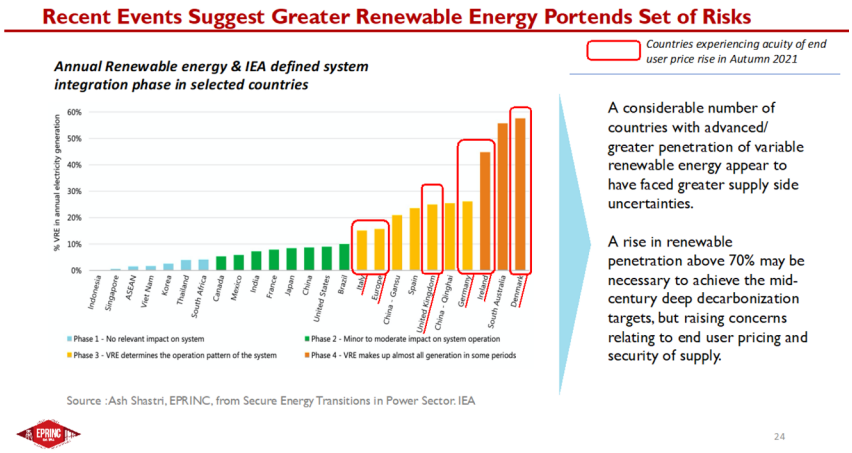
we have substantial cost-effective alternatives to fossil fuels will a full-scale energy transition take place. The most important risk facing the U.S. is that we may attempt a policy driven energy transition that brings our energy systems into a number of failure modest that will be both costly (harming economic growth) and harmful to our security.

2. What kind of risks are there for electric power production and to consumers from a rapid increase in the uses of variable and weather dependent energy sources, such as wind and solar?

RESPONSE:
Solar and wind electricity are not dispatchable systems (systems whose generation can be matched to load as load increases or decreases). Therefore, solar and wind generation require dispatchable backup generating systems when there is no wind or sunlight available. And conversely when sunlight and wind are available, there needs to be considerable integration management to maintain frequency. Capital costs for solar and wind begin at $4,500 and $1,200 per kilowatt, respectively, with no additional operating fuel costs. Backup systems such as simple natural gas peaker plants range between $400 and $800 per kilowatt with operating costs between $0.04 and $0.10.

Grids that integrate intermittent sources need to be designed with considerable flexibility in order to balance generation and load, especially as the percentage of solar and wind generation increases. Furthermore, increasing percentages of wind and solar will have exponential, not linear, effects on grid system management. This can only be increasingly costly. Utility-scale battery storage systems can capture solar and wind electricity during periods of low demand, and later dispatch it as needed. While adding one more cost component, this can mitigate some of the higher anticipated integration costs.

Considerable research and planning are still required to ensure that electric power systems are both reliable and cost-effective as they absorb larger volumes of intermittent power. The following chart illustrates the risks as most large systems that have attempted to incorporate large capacities of intermittent have higher costs and lower resilience. California, which has had an aggressive program to incorporate intermittent energy sources into its grids now has the most expensive power costs in the U.S., except for the Hawaiian Islands.



3. What are the energy security risks to the U.S. from policies designed to limit U.S. fossil fuel production, especially oil and gas, while global demand remains strong?

RESPONSE:
Measures to aggressively reduce GHG emissions have also included policy initiatives in the United States and Europe to limit indigenous production of oil and gas to accelerate reductions in GHG emissions. However, if the energy transition is delayed substantially (a likely outcome) such policies would have a direct and harmful effect on U.S. energy security. For example, several initiatives are underway to limit development of oil and gas on public lands and some measures have been proposed to limit development on private lands. The extent to which these initiatives would curtail U.S. oil production, the U.S. would face rising imports of expensive and insecure petroleum. Revenues from leasing on federal lands would decline and these revenues would find their way to foreign producers. There would also be a shift to foreign sources for critical materials essential for alternative energy sources as it is unlikely the U.S. could produce sufficient from indigenous resources. An accelerated transition, imposed by government mandates and subsidies, would move the U.S. from a position of energy independence to reliance on insecure foreign sources of critical minerals and materials. It would also deny the U.S. billions of dollars of revenue from the sale of oil and gas leases on public lands.

4. What kind of price escalation risks to automobile prices will U.S. consumers face from a rapid transition to electric vehicles?

RESPONSE:
Electric vehicles (EVs) already are priced about 25% higher compared to their non-electrified counterparts. Much of this is due to the procurement costs of raw materials, and the subsequent processing they require, especially for the batteries. EV battery materials are in short supply. Even with lithium and cobalt production increasing to meet expected demand, there is still a mismatch between production and requirements causing prices for these commodities to rise. As worldwide demand for EVs rise, price escalation is likely to accelerate especially if alternative internal combustion engines are not available for sale.

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