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Body

Senate Energy And Natural Resources Committee Holds Hearing On Global Climate Trends

February 03, 2021 10:00 A.M.

SPEAKERS:

SEN. LISA MURKOWSKI (R-ALASKA), CHAIRWOMAN

SEN. JOHN BARRASSO (R-WYO.)

SEN. JIM RISCH (R-IDAHO)

SEN. MIKE LEE (R-UTAH)

SEN. STEVE DAINES (R-MONT.)

SEN. BILL CASSIDY (R-LA.)

SEN. CINDY HYDE-SMITH (R-MISS.)

SEN. JOHN HOEVEN (R-N.D.)

SEN. JOE MANCHIN III (D-W.VA.), RANKING MEMBER

SEN. RON WYDEN (D-ORE.)

SEN. MARIA CANTWELL (D-WASH.)

SEN. BERNIE SANDERS (I-VT.)

SEN. DEBBIE STABENOW (D-MICH.)

SEN. MARTIN HEINRICH (D-N.M.)

SEN. MAZIE K. HIRONO (D-HAWAII)

SEN. ANGUS KING (I-MAINE)

SEN. CATHERINE CORTEZ MASTO (D-NEV.)

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[*]MURKOWSKI: Good morning, everyone. The committee will come to order. I think it's fitting that yesterday was Groundhog's Day as I am still the chairman of the Energy and Natural Resources Committee this morning. I think the last time I was here I said that was my last hearing and any--

UNKNOWN: (OFF-MIC)

MURKOWSKI: Yeah, we're getting close. Anyway, we are here today to consider the nomination of Governor Jennifer Granholm to be the secretary of energy. I'd like to thank Senator Manchin and Senator Barrasso for their work to organize this business meeting and I will turn to them now for their opening statements. Senator Manchin.

MANCHIN: Thank you, Chair Murkowski. And as a former governor, I understand the importance of having one's own team in place, and it is especially important for the president to have the heads of the executive departments who are also members of his cabinet confirmed and on the job. The Senate has a constitutional responsibility to advise and consent to the president's nomination and our committee plays an important role in the process for the principal officers at the Department of Energy, the Department of Interior, and the Federal Energy Regulatory Commission.

It is an important responsibility and I've always admired the diligence and dispatch--the dispatch with which Senator Murkowski's scheduled action on the nominations referred to our committee. I intend to follow her example and carry on in that tradition. I'm pleased and especially pleased that the first nomination committee will consider in this Congress is Jennifer Granholm's nomination to be secretary of energy.

As I said at Governor Granholm's hearing last week, I believe she's extremely well qualified to lead the Department of Energy and I strongly support her nomination. I have known Jennifer since we were governors together more than a decade ago, and I saw how she handled the difficult challenges facing her during the Great Recession when the bottom dropped out of the auto industry in her state. She was up to those challenges. She helped save the domestic auto industry. She diversified Michigan's economy, she brought in new investments in new industry, and she created new jobs and she left no worker behind.

And I know she will continue to apply that mindset at the national level. She has a--the leadership skills, the vision, and the compassion for the people we need at the helm of the Department of Energy to face the climate challenge and, at the same time, preserve our energy security, protect our national security, and cleaned up the coal ward legacy and preserve our scientific and technology--technological prowess. I am pleased to support her nomination and I urge all of my colleagues to join me in voting to report a nomination out today. Thank you, Madam Chairman.

MURKOWSKI: Thank you, Senator Manchin. Senator Barrasso.

BARRASSO: Thank you, Madam Chairman. I'd like to say a few words before we vote. During Governor Granholm's testimony she stated that she understands the need for American energy dominance and American energy innovation. She agreed it was a good thing that the United States is the world's leading producer of oil and natural gas. She agreed that lower energy prices and high paying energy--American energy jobs were good things. And Governor Granholm agreed that American fossil fuels being exported around the world helps keep America and influential energy superpower.

I was encouraged to hear her commit to the development of carbon capture technologies and advance nuclear power. Carbon capture utilization and sequestration and nuclear development hold the keys to significant emission reduction. So she also rightly recognized the need to support America's uranium production and supply of critical--of critical minerals. These are prime examples of areas where there's bipartisan agreement on how to address climate change.

For these reasons, she has the votes to clear this committee and be confirmed on the Senate floor. I expect we're going to work together closely on these efforts when she is at the Department of Energy. Governor Granholm also stated multiple times that she didn't want to see anyone lose their job or get left behind. But this is precisely what the Biden administration is doing.

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By signing executive orders to ban oil, gas, and coal production on federal lands, to kill the Keystone XL pipeline, and to rejoin the Paris Climate Agreement, the president will throw thousands of Americans out of work. Their livelihoods are being sacrificed in the name of the Biden agenda. The Biden administration is telling these oil rig, coal mine, and well workers that they can simply get new jobs, "Building solar panels."

In the words of John Kerry, these policies will give these workers as he said, "Better choices." Well, in 2019, the average salary of an energy worker in the oil and gas and coal industry was roughly \$75,000 a year. Average salary solar panel installer about \$45,000. So if the Biden administration gets its way, it will give every worker and energy worker a better choice of taking a \$30,000 pay cut. That's even if the jobs exist.

To that point, The Washington Post fact checker said John Kerry was offering "False hope, with a misleading use of statistics." So we've heard this all before when President Biden was vice president. It's called the cylinder syndrome. Millions of green jobs that never materialized. The Washington Post fact checker said it expects just 10,400 new wind and solar jobs over the next 10 years.

In Wyoming alone, a ban of oil, gas, and coal leasing on federal land could result in 33,000 workers losing their jobs, where these workers supposed to go, how will they provide for their families. As I said at the governor's nomination hearing, I will not stand by as the Biden administration tries to crush Wyoming's economy. Tens of thousands of workers in other states like New Mexico, Texas, Colorado, and Montana will lose their jobs as well. The leasing ban will also cut hundreds of millions of dollars that are used by states to pay for public schools, for roads, for bridges, and other essential services.

I can't support a Biden administration agenda that throws my constituents out of work and kills the economies of the communities in which they live. During their first week in office, President Biden and his administration have declared war on American energy. I can't, in good conscience, vote to approve his nominee for secretary of energy. And for that reason, I will not support the nomination.

MURKOWSKI: Senator Barrasso. Other members wishing to speak, I would note we do have a quorum, so we can move to proceed to the vote. But if members wish to provide comments prior to. Senator Stabenow.

STABENOW: Thank you very much, Madam Chair. And I want to thank everyone for pulling this together. I just simply want to say as the Senator from Michigan, I've seen up close the leadership that Governor Granholm provided her talent, her--her diligence and working hard every day, and I strongly support her being confirmed. Thank you.

MURKOWSKI: Thank you, other members who wish to make comments? Senator Lee.

LEE: Thank you, Madam Chair. I have great respect and admiration for Governor Granholm. I first met her about a decade ago. I believe it was in the greenroom of the NBC studio here in Washington. We had a good visit then. We've had several great ones since then. Each time I've been very impressed with her on a personal level and on a professional level.

She's capable. She's competent. She's sincere. I wish I could vote for her. I would like to be able to vote for. I so strongly disagree with this administration's energy policies and what it's done already through executive order, by taking actions that in my state are already resulting in dire economic consequences.

I not only hoped but intended to vote for before these executive actions were taken. For reasons stated by Senator Barrasso, I can't in good conscience confirm her to this position knowing that that's the approach this administration is taking. By executive fiat, they are jeopardizing American energy independence and security and they're devastating much of Utah's economy. I can't support that and will reluctantly vote against her.

MURKOWSKI: Other comments? Other members? Seeing none, then, I'd like to proceed to a vote on the one item on today's agenda. The agenda was circulated previously. We have a recording quorum of 11 members present. We'll now move to a roll call vote on the nomination of Jennifer Granholm to be secretary of energy. The question is on the nomination of Ms. Granholm and the clerk would call the roll.

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CLERK: Ms. Murkowski.

MURKOWSKI: Aye.

CLERK: Mr. Barrasso.

BARRASSO: No.

CLERK: Mr. Risch?

MURKOWSKI: Yes by proxy.

CLERK: Mr. Lee.

LEE: No.

CLERK: Mr. Daines.

DAINES: Aye.

CLERK: Mr. Cassidy.

MURKOWSKI: No by proxy.

CLERK: Ms. Hyde Smith.

HYDE-SMITH: No.

CLERK: Mr. Hoeven.

HOEVEN: Aye.

CLERK: Mr. Manchin.

MANCHIN: Aye.

CLERK: Mr. Wyden.

UNKNOWN: Aye by proxy.

CLERK: Ms. Cantwell.

CANTWELL: Aye.

CLERK: Mr. Sanders.

SANDERS: Aye.

CLERK: Ms. Stabenow.

STABENOW: Aye.

CLERK: Mr. Heinrich.

HEINRICH: Aye.

CLERK: Ms. Hirono.

HIRONO: Aye.

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CLERK: Mr. King.

KING: Aye.

CLERK: Ms. Cortez Masto.

CORTEZ MASTO: Aye.

CLERK: On this vote, the ayes are 13. The nays are four. The nomination is agreed to.

MURKOWSKI: The ayes have it. The nomination is ordered reported favorably. Any other comments that members would choose to make at this time? With that, the business meeting is concluded. We can move now to the hearing that is scheduled this morning. And I will turn to Senator Manchin.

MANCHIN: Thank you, Madam Chair. So this committee has proven itself ever ready to rise to the occasion of working together to identify and enact solutions to both present and future issues facing our country. As chairman, I'm committed to continuing these traditions and working with all my colleagues on the issues that are important to their states and to our nation.

Climate change is one of those issues. Critical not only to our states and our nation, but to every country around the world. To address climate change, we must face it head on on a global scale and in every sector of our economy. No doubt, we will all have differing views on the best way to do that. But first, I believe we must begin with a common understanding of where we stand today, and what got us here.

I have long said that you're entitled to your own opinions, but not your own facts. And it is in that spirit that I wanted our first hearing of this new Congress to focus on setting a baseline of global climate facts from which the commission can build on as we advanced climate solutions. In 2019, a few of my colleagues and I visited the Arctic, where we met with several leaders.

In each country we visited, we saw the impact of climate change firsthand and heard from those leaders that it was a matter of survival, not a partisan politics. I will adlib here, when we had been an Ottawa, the United States was the only state--was the only country, the United States was the only country of all the Arctic nations that basically used climate as a political divide. They all came to conclusion, John, we were all there. So we were and--and it was a great CODEL that we had with--with the second--with our--our chairman--our former chairman, almost. Maybe.

This committee has shown the ability to rise above that and, as evidenced by the recent enactment of the Energy Act, all--are all of the above energy innovation package with provision sponsored by almost 70 senators last year. It is abundantly clear that the dwelling on partisan rhetoric shuts down debate, collaboration and progress. And as we look for ways to heal the division in our own country, I believe that one way for us to overcome our differences of opinion, is by first grounding ourselves in the facts, which will serve as a guide going forward.

Before hearing from our panel today, there's one fact that I would like to serve as our starting point. And that is, climate change is real, and largely linked to human activity. Scientists around the world, including in our own national laboratories, are researching many aspects of climate change. And the scientific record is convincing and growing. This year--excuse me. Oh, boy. I just got tested.

(LAUGHTER)

This, this year, the Intergovernmental Panel on Climate Change--

UNKNOWN: (OFF-MIC)

(LAUGHTER)

MANCHIN: That was a good one, John.

(LAUGHTER)

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This year, the government--Intergovernmental Panel on Climate Change will release its sixth comprehensive report on global climate change and I look forward to learning the new findings. We also have an immense amount of energy data at our fingertips, thanks to the incredible work of the U.S. Energy Information Administration and the international organizations like the International Energy Agency. A snapshot of that data shows that in the past 10 to 15 years, the United States has seen major transition in energy markets and we have--we'll be leaving these--these two panels up here for you all to kind of view.

The cost of natural gas has been cut in half from 2010 to 2020. And the cost of wind has fallen by 70 percent. And the cost of solar has fallen by 90 percent. When paired with increasing energy efficiency, this has led to a rapidly changing electric power grid system that is much less carbon intensive. But in which coal power plant retirements have devastated communities across my home state of West Virginia, along with many traditional energy producing states represented on this committee.

That raises two points that we must recognize about fossil fuels. In the domestic context, the energy transition has increased hardships in areas of the United States that have powered our nation for decades by mining its coal, producing its fuel, and generate--generating its electricity. In our energy mix--as our energy mix has changed, concern about the impacts on these traditional energy communities has and will remain front of mind for many of our members. I will continue to work hard to ensure that those communities are given new opportunities to thrive, including as a member of the new IEA global commission focused on examining the impacts of a clean energy transition on individuals and communities.

I'm honored to join this effort and confident our discussion today will provide a strong foundation for discussions ahead as we work to address climate change and leave no one behind. We must also recognize that also fossil fuel--although fossil fuel consumption is dropping in the U.S. power grid, the global trends in--in fossil fuel use should make us all recognize that fossil fuels aren't going anywhere any time soon, particularly in countries that are seeking to expand access to electricity and energy in order to adjust poverty.

In both domestic and international arenas, however, the fact is that we have tackled these challenges before, and we can overcome them again by focusing on the technological innovations needed to do so. Following the Clean Air Act Amendments in 1990, electric utilities across the United States developed and adopted equipment that aided their compliance with the noodles to reduce or eliminate SOx and NOx and particulate matter.

By outlining the facts about our pollution and developing the technologies needed to manage it, utilities were able to adapt to improve public health and maintain jobs, all at a lower cost than what was initially projected. This provides one principle for our committee's work going forward. The power of innovation combined with keeping all of our options on the table will help us create high quality jobs, reach our environmental goals, and do so cost effectively.

I also think it applies in the global arena. As we look to lead the world on tackling the climate challenge, we must remember that the rest of the world isn't necessarily ready--ready to follow the same pathway as we do. By pursuing an all above energy policy and a broad array of emissions, including reducing technologies, we can simultaneously build our technology export opportunities and diplomatically relationships with those countries who choose to utilize their own fossil resources.

Today's panel includes experts to bring domestic as well as global perspectives, including Dr. Birol, the executive director of the International Energy Agency, Dr. Richard Newell, the president and CEO of Resources for the Future. Dr. Angel Hsu, an assistant professor at the University of North Carolina, Dr. Scott Tinker, the director of the **Bureau of Economic Geology** at the University of Texas, and Mr. Mark Mills, a senior fellow at the Manhattan Institute.

I would like to welcome all of you to the committee for this important retrospective discussion that will set the scene for forward looking solutions. I look forward to hearing about this discussion, and the trends and current state of play in global and domestic energy markets, technologies, policies, and emission reductions. Of course, the raw data and percentages are just the tip of the iceberg.

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Below the surface, the changes we've seen were being driven by innovation, policy, markets, and incentives. This discussion will serve an important role in setting a baseline of common facts and a historical perspective for this committee from which we identify the common challenges and opportunities and move quickly to address them. With that, I'm going to turn it over to Senator Barrasso for his opening statement. Senator Barrasso.

BARRASSO: Thanks, Senator Manchin. And you know, in December of last year, Congress passed historic bipartisan climate innovation legislation that I worked on closely in the Environment and Public Works Committee with Senator Carper. This was the most significant greenhouse gas reduction bill to be signed into law in well over a decade. Importantly, it won't raise costs for American families. So I look forward to working with--with you, Senator Manchin, on energy and environmental innovation in this same bipartisan spirit.

Today's hearings intended to set the baseline of knowledge about contributions to global emissions. It's a very worthwhile goal. We're holding this hearing at a very critical moment. Over the past two weeks, the Biden administration has rolled out a series of indefensible and ineffective climate policies that will sacrifice, that's the term and I--term used by the nominee to be secretary of energy, the sacrifice tens of thousands of American jobs.

This hearing can provide an important reality check. I think we have to stop fooling ourselves into thinking that eliminating our fossil fuel production is going to solve the problem, because it won't. It will just make America less competitive and less energy secure. The energy industry has been a critical engine of economic recovery in the past.

After the Great Recession, while the rest of the economy was still struggling, the oil and gas industry was investing and adding jobs at a brisk pace. Because of these investments, U.S. has some of the lowest energy prices cost to consumers in the world. Now President Biden wants to kill energy jobs and drive up energy prices. Undermining America's energy security will not solve climate change.

It's unrealistic to expect that China, India, and Russia and many other large emitters will stop using fossil fuels. It's just unrealistic. They know the importance of affordable energy to their own economies. Eliminating our fossil fuels isn't going to change any of that. As data from the International Energy Agency has shown the U.S. has become a significantly smaller source of carbon dioxide emissions worldwide.

U.S. emissions now account for just 14 percent of the global total. Well, that's down from 25 percent, just 20 years ago. Over that same period of time, the share of total emissions from China jumped from 13 percent of the world's carbon emissions all the way up to nearly 30 percent. From 13 to 30 percent, of the world's carbon emissions due to China.

And it's not just China. Emerging economies like India, Brazil, South Africa, and others are all increasing energy use as they develop and grow in population. The International Energy Agency expects that by the year 2030, energy use in these and other developing countries will jump by almost 20 percent.

With almost a billion people still lacking access to electricity around the world, addressing climate change isn't a priority for developing countries, especially if it hampers their economic development. They do not consider it a priority in their effort for economic development. Affordable, reliable and scalable energy are the keys to reducing energy poverty, to improving human welfare, and to powering economic growth.

These trends means we have to--means we have to focus on practical solutions. At its most fundamental level, reducing greenhouse gas emissions is a technology challenge. Instead of raising the cost of traditional energy sources, we should work to lower the cost of alternate technologies like carbon capture and advanced nuclear reactors. Until that happens, traditional fuels are going to continue to capture the lion's share of global energy demand.

An approach based on innovation plays to our strength in America. American innovation is the key to reducing global emissions and our goal should be to encourage, support that process and that progress. Thank you, Mr. Chairman.

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MANCHIN: Thank you, Senator. Now we're going to turn to our witnesses. Our first witness will be Dr. Birol. Doctor, thank you so much.

BIROL: Okay. Thank you very much, Senator Manchin. Senator Manchin, Senator Barrasso, still the chairman, Senator Murkowski, members of the committee, dear fellow witnesses, greetings to all of you from Paris from International Energy Agency headquarters. So before starting my words, may I congratulate the Governor Granholm for getting the approval of the committee. And if confirmed, I am looking forward to work with Ms. Granholm as the next secretary of energy of the United States.

And also, many thanks to Senator Manchin for agreeing to be a member of our global commission on people-centered clean energy transition. Thank you very much, sir. Joining global leaders focusing on this issue.

It's an honor for me to be here is the head of the IEA to be in front of you. I had the pleasure to testify several times and I can tell you that every time I learned a lot from you. And I understand it's a special group as work on a bipartisan basis and achieve several good results. The last one being a--the Energy Act of 2024, which I think you and I congratulate you.

Now, you have my full testimony in front of you, I just want to focus on three points from the--from the global picture. First, current state of play international climate change. Our climate change is essentially an energy challenge. Why? Very simple. About 80 percent, in fact, more than 80 percent of the emissions causing climate change come from the production and use of energy, and methane comes on top of that.

If you look at the major emitters, I'll give you four of them, four major ones, China is by far the largest emitter. Since 15 years, China is the largest emitter responsible about 30 percent of global emissions. But China is also by far the leader of solar energy. The solar energy in China is equal to all the other countries put together.

India emissions are about 7 percent. But on a per capita basis, it is one of the lowest in the world. European Union, also about 7 percent. And I should mention you that the latest EU stimulus package, we spent billions on new clean energy technologies. Without the state's, USA's (INAUDIBLE) divert emission reductions over the recent years. And today, U.S. emissions are half of that of China. But on a per capita basis, still very, very high. So this is the picture where we are.

Second point I want to mention is the technologies we have in hand to reach our climate goals. We have one group of technologies which are already ready for the markets. Solar, wind, onshore wind, offshore wind, hydro power, geothermal, nuclear power. They are ready for the markets. But they are, alone, not enough. By far, not enough to reach our climate cost.

Innovation is the, Senator Barrasso mentioned, is the key word here. And the innovation in the carbon capture and storage in the industry, hydrogen advance nuclear will be critical to reach our climate costs. We have some which are ready. They are not enough. We need innovation, other cleaner technologies being--are part of our markets.

Third point. Clean energy transitions will have broader implications. And there are some challenges. I want to highlight only two of you maybe we can discuss in length in the next minutes to come. The first one is the challenges coming from the critical minerals.

On the ambitious climate policies, the energy sector will become a major force in driving demand for copper, lithium, nickel, and cobalt. And we see extreme vulnerability of our global system in the next years to come. It is the reason IEA is preparing a major study to look at the global challenges that can arise from this challenge.

Last point I want to mention is another broader implication is the--how the government's will be able to proceed clean energy transition without having major impact on the communities on the workers. So a smart, well designed policies will be critical in order to have everybody on board. So these are two major implications while we pursue clean energy transition around the world.

Once again, Mr. Chairman, thank you very much for inviting the International Energy Agency. I am--I am looking forward to your questions and the comments of my colleagues. Thank you.

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MANCHIN: Thank you, Dr. Birol. And next we have Dr. Newell for his opening statement. Dr. Newell.

NEWELL: Senator Murkowski, Senator Manchin, Senator Barrasso, distinguished members of the committee, thank you for the opportunity to provide my testimony today. My name is Richard Newell, I'm the president and CEO of Resources For the Future, an independent nonprofit research institution that has informed energy and climate policy for decades.

RFF's mission is to improve environmental Energy and Natural Resource decisions through impartial Economic Research and Policy engagement. The views expressed today are my own and may differ from those of other RFF experts.

I've had the opportunity to testify before this committee previously as the administrator of the U.S. Energy Information Administration. I therefore appreciate the importance of decisions informed by the best data science and analysis available. It's my pleasure to be with you here again to speak today about global climate energy and emissions trends, particularly from a U.S. perspective.

The climate is unquestionably changing and human activity is the primary driver. Since the Industrial Revolution, humans have released increasing amounts of greenhouse gases to the atmosphere, leading to higher average global temperatures, melting icecaps, sea level rise, and other impacts. The consequences are stark. The average global temperature has already risen by one degree Celsius and regions like Alaska have confronted increases twice that amount.

The U.S. is the second largest emitter of greenhouse gases after China, and we remain the largest contributor to cumulative historic greenhouse gas emissions. 83 to 85 percent of us emissions come from the production and use of energy, particularly from fossil fuel production. Our emissions trajectory hinges on economic growth, improvements in energy efficiency, and shifts to low or zero carbon energy sources.

These shifts are driven in turn by three major forces, energy market conditions, technological innovation in public policy. U.S. greenhouse gas emissions have decreased declined since 2005, primarily due to declining coal-based electricity generation and increasing power from natural gas and renewable power sources. Wind and Solar have experienced cost declines of over 70 percent since 2009, and have benefited from tax credits and other policies.

Natural gas power has benefited from low prices due to shale gas innovation. There have also been substantial advances in technologies that can complement intermittent renewables to provide reliable power, such as energy storage, advanced nuclear, advanced geothermal systems, and natural gas with carbon capture. The transportation sector is now the largest source of us greenhouse gas emissions, although transport emissions have fallen by about 5 percent since 2005, principally due to increased fuel economy of vehicles.

The cost and range of electric passenger vehicles have improved considerably. But aviation shipping and long haul trucking are more difficult to electrify. U.S. emissions from industrial sources such as steel, cement, and petrochemical production have shifted only modestly since 2005. Industrial processes that require very high temperatures, or have process related emissions require distinct set of pollution solutions, possibly carbon capture and storage, hydrogen, or advanced nuclear technologies.

Outside of energy, agriculture, forestry, and other land use and missing sources present distinct issues and they also present opportunities for carbon removal through biomass, carbon sequestration, and forest grasslands and soils. Direct air capture of carbon is also now possible through technological means.

Because the energy system is so widespread and complex, reducing emissions will require a broad and inclusive approach to incorporating new technologies. We can't know in advance which technologies will become most competitive, so expanding our solution set makes ambitious strategies more feasible.

I'll conclude with three key observations. First, the concentration of greenhouse gases in the atmosphere is increasing rapidly, causing our climate to change. Fossil fuel use is the leading cause and the U.S. is a major contributor. Second, a wide array of technological options is both necessary and available to reduce emissions

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across the diverse energy landscape. And finally, given cost reductions and advances in clean energy and other emission reduction technologies, ambitious reductions are--are now more achievable at substantially lower cost.

The success of emissions reduction strategies will depend on how well they meet the needs of diverse sectors, incentivize consumers and producers to choose low emission options, and spur technological innovation. Research shows that incentive-based policies coupled with targeted innovation support are the most effective means to align private sector incentives with society's emission reduction goals.

Innovation flourishes when accelerating demand for new technology is coupled with robust support for research and development. Senators, I want to thank you again for this opportunity to appear before you. I'll now conclude my remarks and look forward to your questions.

MANCHIN: Thank you Dr. Newell. And next we have Dr. Hsu.

HSU: Thank you, Senators Manchin and Barrasso and members of the Committee on Energy and Natural Resources for inviting me here to testify today. It is an absolute honor to be here and share my knowledge on these issues. I'm a contributing and lead author to several global climate assessments and director of the data driven Environmental Policy Lab at the University of North Carolina Chapel Hill.

Much of my research has focused on China and its contributions to global climate and energy policy. Maintaining primarily a global perspective, I would like to address four points. One, where we stand today on global climate change, two, where our existing policies stand and limiting global temperature rise, three, China's role in combating climate change, and lastly, the potential for some national actors and the business community to fill climate policy shortfalls.

First, starting with the current status of the global climate, the latest climate science literature describes a narrowing window for meaningful climate action to restrict global temperature rise to 1.5 degrees Celsius. As Dr. Noah just said, temperatures have already risen by about 1.1 degrees Celsius. Emissions increased on average around 1 percent each year over the last decade, with 2019 seen record high emissions levels predominantly driven by global fossil fuel consumption.

Despite the devastating impacts of COVID-19 however, it has been the single largest short term influencer of greenhouse gas emissions. In 2020 carbon dioxide emissions reductions due to COVID-19 related shutdowns are estimated to be between 7 and 9 percent. This precipitous drop in emissions has provided now an opportunity for countries like the U.S. to consider post COVID-19 recovery plans with climate change and energy policy considerations.

There is a strong economic case for the transition away from fossil fuels to renewable energy. Costs have continuously declined for renewable energy and demand has remained robust compared to fossil fuels. For example, in 2020, over 70 percent of utility scale power that was added to the U.S.'s generation capacity was in the form of renewable energy.

Second, in terms of the current policy status, the science is clear that we need to get to zero emissions by 2050 to contain global--global temperature rise to 1.5 degrees Celsius. Ideally, global emissions should have already peaked in 2020. One analogy that has been used to describe the challenge is that we need emissions now to fall off a cliff. If the world had begun steadily decreasing emissions around 10 years ago, we would only need to have been reducing emissions by 2 percent per year.

Now, global emissions need to decrease--decrease by 7 percent per year until dropping to 0. The reality is that the ambition of national government climate policy efforts are woefully inadequate to stay within our remaining carbon budget. At our current emissions rate, we would deplete the entire remaining carbon budget within the next 10 years.

While the data show that country's track record for addressing climate change has not been adequate, around 127 countries recently have pledged to decarbonize, including China, the world's largest emitter of greenhouse gas

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emissions. China's president, Xi Jinping, announced last September at the UN General Assembly that it would commit to become carbon neutral by 2060. This carbon neutrality pledge is significant.

If successful, it could cool the planet by about .2 to .3 degrees Celsius by 2100 on its own. But to meet this carbon neutrality goal, China will need to eliminate coal as part of its energy mix, which in 2018, generated 65 percent of its electricity. They have a plan to phase it out by 2050 and generate 90 percent of all electricity from non-fossil sources, including renewables and nuclear energy. To do this will require a 16-fold increase in solar energy, a 9-fold growth in wind power, a 6-fold increase in nuclear, and a doubling of hydroelectricity.

China will also need to grow renewable energy investments to around \$15 trillion U.S. in the next 30 years. It currently already tops global clean energy investments at around \$100 billion U.S. each year, more than the U.S. and EU combined. And it is a leading manufacturer of wind, solar, and electric vehicle technology.

The U.S. and the world can have confidence that China will meet this carbon neutrality target. The country's past record demonstrates that had--it has met or it has come extremely close to meeting every single energy and environmental target the country has set. It is already on track to overachieve its 2020 and 2030 carbon intensity goals and independent satellite data confirm that China has achieved significant reductions in air pollution already.

Despite the importance of Chinese climate commitments and other existing agreements, however, they still won't get us all the way to net zero. Our research demonstrates that nearly 6,000 cities, states and regions and over 50 However, companies existing climate efforts will lower greenhouse gas emissions by 1.2 to 2 gigatons of carbon dioxide equivalent in 2030. This is additional reduction, and it amounts to roughly 4 percent of the world's total annual greenhouse gas emissions, as much as Japan and Canada emit in a single year.

In the U.S., these commitments could provide at least half of the reductions needed to meet its Paris pledge. As of October 2020, more than 1500 businesses, 826 cities, 103 regional governments, including 24 U.S. states, have already made net zero commitments.

To end how national governments designed post COVID-19 economic recovery strategies will largely determine how much global emissions rebound to pre-COVID-19 levels. Global competition and cooperation on clean energy building on continued progress from some national and business actors is one vehicle towards our decarbonization goals. Thank you very much. And I look forward to further discussion in your questions.

MANCHIN: Thank you, Dr. Hsu. And now we'll hear from Dr. Tinker. Doctor, I think you might be--

TINKER: --Good morning. Good morning.

MANCHIN: Oh, there we are. Okay.

TINKER: Senators, distinguished members, fellow panelists. It's an honor to be here today with you. Senator Murkowski, thanks for your leadership. Senators Manchin and Barrasso, welcome. I look forward to working with you.

We all share a common desire to provide affordable, reliable energy in order to grow healthy economies and lift the world from poverty, while also minimizing environmental impacts including climate, land, water, and air. There may be a perception of division, but I think it's a false divide. Let's not let division triumph.

I planned to mention a bit about my background and highlight a few facts about global poverty, population, and the economy, but that's all in my written testimony and it can be made available to anyone listening in. Instead, I'd like to tell you a story.

The films we have made the past decade on global energy, the environment, and poverty are nonpartisan and introduce critical thinking of these important issues about these issues. They're used by educators all over the world, for students of all ages. As such, I am asked by teachers and faculty globally if I could visit in person or Zoom in with your students for a short discussion. It means so much with the kids, they say. I try to do as many of these each month as I can.

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Just before COVID, I was visiting an environmental class of about 50 lower division university students in an ask me anything format. And near the end, one student said and I quote, "Why does any of this matter? We're all gone in 15 years anyway." "What do you mean," I asked. "Humans. We're gone because of climate change in 15 years." Trust me, I'm rarely speechless.

I asked the class how many felt that way. 50 percent raised their hands. I was stunned. I asked why they felt this. And if they could describe what would actually wipe out all of humanity in 15 years. They couldn't describe how anyone would actually die. They just said they were being taught that climate change is an existential threat and hearing that from their leaders. To them, that meant humans will no longer exist.

I was deeply disturbed by this on many levels for many weeks. Where was the critical thinking? The nonpartisans, nonprofit Switch Energy Alliance that I formed many years ago makes critically thinking films on energy and the environment. We work with AP environmental science, high school teachers across the country the past few years to develop truly objective curriculum on energy for classes across the U.S.

It didn't take long to discover how bias is introduced. Here's an example of two essay questions from an AP test. What are the environmental benefits of offshore wind? What are the environmental impacts of tar sands? The questions can only result in the student being--seeing benefits of one option and the impact of the other, when in fact, we all know and we have heard from others, there are pros and cons to both.

This happens at the highest levels. Just this morning, E and E reported that a new National Academies report offers a comprehensive roadmap for achieving a carbon free economy by mid-century and it concludes, "On the edge of feasibility." Of course, if the question posed to the committee was how do we reach a carbon free economy, by definition, the report have to spell that out.

Critically thinking, when asked how do we reach a carbon free economy without damaging the land, water and locally the process? In other words, how do we avoid robbing from nature, Paul--Peter, to pay climate, Paul? I trust we all believe that humans will be here in 15 years, and hopefully well beyond. As such, each of us carries a remarkable burden.

We do not want students around the world to feel duped someday when they realize that clean isn't really clean. To be sure, coal, oil, and natural gas to a lesser degree impact the environment. Let's continue to clean them up, especially the emissions. But all forms of energy impact the environment.

As a geoscientist, I'm not against mining, but I know that low density sources of energy, such as solar wind, biofuels, and batteries will require an unprecedented scale of mined, sometimes toxic, resources from Earth that must be disposed of when they wear out and they get disposed in the land and the ocean. And though--although level-wise cost of electricity and energy have fallen, the cost of full scale, we're going to back up (INAUDIBLE) makes it more expensive for the consumer.

Ask California and Germany. It's not clean or renewable or cheaper. It's just different. So let's converge on a plan that provides equitable energy access globally and addresses not only emissions, but all environmental (INAUDIBLE). The plan should focus on some (INAUDIBLE) the CO2 solution produced actual CO2 emissions into our single global. Protect the rest of the environment, be affordable, dispatchable and scale, be deployed or deployable in the next two decades, protect U.S. security, U.S. economy, and lift the world from energy and economic poverty.

Fortunately, solutions exists. Options you have heard from other witnesses are remarkably consistent. Switching from coal to natural gas, especially in Asia. If Asia doesn't act, it won't matter. Preserve the nuclear fleet in the U.S. and support nuclear globally, especially small modular reactors, and streamline deep borehole disposal. Accelerate efficiency across all U.S. and global sectors.

Natural gas nuclear efficiency in partnership with solar and wind CCUS, hydro, geothermal, hydrogen, and others provide dispatchable reliable, affordable energy today and it preserves industry and grows higher wage jobs. The U.S. can lead through investment technology, federal and state incentives, and efforts to find scalable, affordable,

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timely solutions. Although tempting, we've got to resist the well-intended efforts to restrict market opportunity, optionality, which often result in unintended consequence. Thank you for your opportunity to speak to you today.

MANCHIN: Thank you, Dr. Tinker. And finally, we have Mr. Mills thank you for being here. Mr. Mills.

MILLS: Thank you, incoming Chairman Manchin and very much for--

MANCHIN: --We'll--we'll get this worked out pretty soon.

(LAUGHTER)

MILLS: And--and thank you outgoing Chairman Murkowski. I--I was tempted to make an allusion to Bill Murray and the--the--who we all know and love, but thank you for inviting me. It's--it's an honor and a pleasure. And Senator Barrasso, members of the committee.

Since the purpose of this hearing, is to establish a baseline on the state of affairs regarding carbon dioxide emissions associated with energy, permit me to note three basic realities. And each of them have implications for the subject at hand. These are realities, in fact, that help explain why, as the committee's Joint Staff memorandum notes, that global carbon dioxide emissions continue to increase prior to the pandemic lockdowns, despite massive investments in non-hydrocarbon energy production, both in Europe and the United States and China.

First, it's indisputable, and it's a good thing, that the world will use far more wind turbines and solar machines and electric cars in the future. The reason for that, aside from obvious policies encouraging all three, is anchored in the fact that those technologies are all profoundly better than they were a decade or two ago. And given the magnitude of future global energy needs to bring people out of poverty, more options are always better.

Second, it's equally indisputable that all energy machines are, necessarily, built and operated using materials that must first be extracted from the earth. Replacing hydrocarbons with the wind, solar, and battery powered machines, the principle vectors in most countries on these discussions, doing that constitutes a major shift in both the nature and the quantities of these energy materials.

It's a switch from using mainly liquids and gases to using solids. And it's a switch that, on average, results in a tenfold increase in the quantity of materials mined and processed per unit of energy delivered to society.

And third, the United States is today, and will be for the foreseeable future, a net importer of either wind, solar, and battery machines or key components for those machines, or in fact for most of the critical energy, minerals, and materials needed to build them. These realities have implications in the accounting of carbon dioxide emissions. They also have economic, of course, geopolitical, environmental, and even human rights implications.

I know, briefly, that the U.S. is essentially, as the committed knows, self-sufficient today in net hydrocarbon use. It's an importer, though, of alternative energy materials and machines. This means that replacing the former would supply 80 percent of America's energy with the latter would replace a very large share of the domestic GDP with imports.

So given the way the world is, not as we wish it would be, increasing domestic use of wind solar batteries results in a de facto export of carbon dioxide emissions. That's because mining and processing of energy minerals and the fabrication of energy machines is inherently energy intensive. And most of that energy use takes place offshore.

By calculating the magnitude of that, we could call it offshoring of emissions, it's actually complex. There are some analyses have, for example, looked at the impact of processing battery materials, or fabricating battery components in China, which in fact, this committee may know, is a major if not the dominant share of such industries.

With China's grid, that's two-thirds coal fired, that processing and fabrication leads to a supply chain carbon dioxide emissions that constitute a significant share, and can even be the entire share of any emissions that are eliminated by replacing a combustion engine with an electric vehicle in many parts of the United States.

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In fact, they're more broadly looking at global mining. Its oil use for heavy machinery, of course, rivals the total oil use of global aviation, of course, before the great lockdowns. Meanwhile, the path contemplated in the Paris Accord will lead to the greatest acceleration in demand from mining that the world has ever seen.

This all points the need for a realistic supply chain emissions analyses, accounting of the carbon dioxide of where it really comes from and de facto export of carbon dioxide emissions, something that's lacking in the current carbon accounting. It also points, frankly, to an opportunity for the United States to revitalize our domestic mining and mineral processing industries, something, I note, that China has been focused on for years.

I'd like to conclude by noting that there's some irony in the fact that the world is coming full circle to revisit the importance of mining. It's humanity's oldest industrial activity, in fact. Way back in 1934, speaking of baselines, the great American philosopher and technology historian Lewis Mumford, who was born in Queens, by the way, observed in a seminal book about technology and civilization, that the industrialization of mining was a major, and in fact, in his view, it was the primary vector, the primary driver in the creation of modern capital markets, in the organization of labor, and an end in our understanding of our relationship with the environment.

Given green energy plans, I expect we'll be revisiting those lessons in the coming decades. I thank you for the opportunity to testify.

MANCHIN: Thank you, Mr. Mills. And now we will turn to our chairwoman for her questions. She was just regrouping there and she's ready.

MURKOWSKI: I'm absolutely ready. I was getting ready to go over to help and then come back. But you've given me an opportunity--

MANCHIN: --You're going to start right out, ma'am.

MURKOWSKI: I'm going to start right off--

MANCHIN: --You're still officially our chairperson

MURKOWSKI: I do have to comment, Mr. Mills. Your last statement there, or included as part of your last statement, the--the recognition or the reality that we are switching our vulnerability, if you will, from liquid state to soon solid state. That's something that I think we need to be thinking about. And it's--it's something that this committee has focused on.

Senator Manchin and I had our critical minerals bill that we included in the Energy Act, but we know we need to be doing more with that regard. And what you have highlighted here, I think, is very important. And--and you, Dr. Birol in your comments, mentioned much the same.

And again, I want to--I want to extend my thanks and my appreciation to Dr. Birol, you and your leadership, the opportunity that I have had to serve as a member of the Global Commission on Energy Efficiency, some of the best practices that we have been able to work through and talk about. I just so appreciate your--your leadership there.

I--I guess I would direct this question to--to both Dr. Birol and--and you, Mr. Mills. We have seen recent executive actions. Senator Barrasso mentioned them earlier when we are taking up the--the confirmation of Jennifer Granholm for secretary of energy. But these actions potentially jeopardize the--the very future development and production of U.S. fossil fuel resources.

We know U.S. LNG markets, our exports, are particularly important for markets in Asia. So the question to you both is, if future U.S. oil and gas exports are no longer available within the broader global market, this reduction in--in supply is going to be met elsewhere. So to--to you perhaps Dr. Birol what--what countries benefit the most from U.S. oil and gas exports?

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And where will future supplies then come from if--if the U.S. cuts its exports? And then following that, Mr. Mills, if you can speak to what a reduction in--in U.S. oil and gas production really means for the development of the global markets, I appreciate your views on this. Dr. Birol?

BIROL: (OFF-MIC) very much. Thank you very much, Senator Murkowski, once again, and thank you very much for your leadership in addressing one of the critical issues of a clean energy, namely energy efficiency, best practices for households, for industry, for transportation sector, with other leaders around the world.

Now, if the United States production is set to decline, the--and if there is still strong demand for oil around the world, the--the gap will be met mainly by the cheap cost of Middle East countries. Having said that, while we look at the current oil demand numbers as a result of COVID, they went down substantially. And we do not expect that the demand will go there where it was before the COVID in next three or four years to come.

This is on that issue. And there is a huge amount of spare capacity in the markets now, which the markets can make use of. In terms of LNG, the U.S.--the flexible nature of us LNG contributed a lot around the world and brought the price of gas down since last few years. And interestingly enough, the main purchaser of U.S. LNG today is, by far, is China.

From an emissions point of view, U.S. LNG, if it replaces coal in Asia, it can lead to significant emission declines, both in terms of CO2 emissions but also for air pollution. Having said that, the methane emissions are very important here and it is very important that the--to note that several customers around the world will soon look at the methane footprint of the--their gas exporters, and therefore perhaps an important task for the current administration to take note of. Thank you,

MURKOWSKI: Appreciate that. Mr. Mills?

MILLS: Thank you, Senator Murkowski. The--I would say first that the IEA has been remarkably honest. I don't mean this as a--in a surprise or shock at outlining the realities of where the world's energy markets are--are going in the near term. Both with respect to the demand for critical energy minerals, but also with respect to where oil and gas demand are trending, given the nature of the world. So it's my--my go to, for we'll call it honest analysis at the global level.

Your--your question about what will happen to the U.S. and world development is, I think a particularly appropriate one is. As--as we know, the demand for oil is not, and in all the forecast show, it's not going to decline, it's going to go back up to roughly where it was. Who produces that oil, and who's going to produce the natural gas? We--we know, I would add, to the OPEC nations, Russia is the other principal beneficiary and some other African nations, but principally it's Russia and OPEC.

The--the world divides simplistically into oil and gas. Transportation and electric power, roughly speaking. And the United States' role in the transportation markets and the cost for people to get around in cars, we can distill our impact in a very simple way. We--we in America we're essentially responsible for the collapse of world oil prices to the benefit of world consumers who drive and fly.

There will be about a billion cars added to the world's roads over the coming couple of decades. Even if all the existing cars become electric, which is going to be extraordinarily difficult. There will still be an enormous demand for oil. Markets, consumers will want that oil to be cheap. We drove the price down. We can continue to drive the price down. It's essentially the swing producer.

That's what's happened the United States became, in the last decade, to the total shock of the world, the swing producer, it's to the detriment of us oil companies, by the way, because it means you're a price taker. You're not a market maker. You're--every time prices go up, as we all know, it's like Mardi Gras again in the oil fields and they start drilling and prices get--collapse.

Natural gas is the go-to source of electricity for the world. Not--coal is still growing, as you all know, but natural gas is the go-to. And there as well, the U.S. shale fields directly caused the collapse in global gas prices, just the--just

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the anticipation of the U.S. entering global markets caused prices to collapse. Gazprom began negotiating and renegotiating new prices with--with Europe. The world benefited. The world's electric consumers benefited from American shale fields.

Lastly, I'll note in terms of development, the United States, and this sounds a little bit of bombastic because--but I'm a Canadian as well as an American. The American oil and gas industry is the technologically most sophisticated in the world. Its pathbreaking capabilities not just to produce marginal oil and gas more inexpensively, but more efficiently, which in the fuel cycle for carbon dioxide emissions matters, and more environmentally sensibly.

So we--we are the pioneers in that. If we push that oil production and gas production to parts of the world, which are not as cautious and not as good at it as us, the oil and gas will be produced there. It will be less efficient, less clean, and probably more expensive, which I think, net, bad for the world.

MURKOWSKI: Mr. Chairman, thank you. Ranking Member Barrasso. I think both gentlemen have--have well pushed me both beyond my time, but I think their responses and the reality of the role that the United States has played in a very dramatic way very quickly, in terms of being that player in--in production in what we have been able to--to do with our--with our allies, is nothing short of extraordinary. And I would certainly hate to see us go backwards with that very significant and dominant role. Thank you.

MANCHIN: Thank you, Madam Chairman. And with that, Senator Heinrich has another conflicting committee meeting, and I want him to take my time right now.

HEINRICH: Thank you to the former and current chairman. Dr. Newell, I--I wanted to ask--the ranking member brought up the concern that embracing renewable power sources could lead to unaffordable energy supply. Could--could you sort of walk us through the major sources of electric power generation today and how they stack up based on levelized cost of energy? In other words, what sources are most expensive today and what are the cheapest and what does that say about where we're going?

NEWELL: Thank--thank you, Senator. So there's been dramatic change over the last 10 years or so in the level of what's called the levelized cost of electricity production, which takes the upfront capital cost of building a new plant. It also takes account of the fuel costs that you would use to operate a gas or a coal fired plant. And it puts those two things together and expresses it in, you know, dollars or cents per kilowatt hour.

So what we've seen is, as I mentioned in my testimony, a very, very substantial drop in the cost of both wind and solar power since 2009. solar power has come down in its levelized cost by about 90 percent. And wind, which had been thought of as actually a relatively mature renewable technology, has actually come down by about 70 percent.

What that has done is it has really flipped on its head the relative stacking of where new capacity additions are coming from. And whereas it was true in the past that natural gas was actually a favored low-cost provider of electricity, that has changed substantially. What we've seen over the last decade is that renewables, both wind and solar competing with natural gas for new capacity additions.

The U.S. Energy Information Administration, which is where I look to for kind of constant tracking of this levelized cost of electricity, is coming out with its annual Energy Outlook today. It hasn't been released yet. But in a preview of that the EIA kind of reconfirmed what it has shown over, you know, many years now, which is that renewable energy in terms of new capacity additions for electric power is taking increasing market share, and that looking forward renewable power will actually be the majority of new capacity additions. That's without any future changes in policy.

If you look at the other sources of electric power, natural gas tends to be there next. Natural gas combined cycle. And then, coal and nuclear power in terms of new capacity additions have--are relatively more expensive now compared to both natural gas and renewables.

HEINRICH: Obviously, we've seen a lot of stranded coal assets as--over the last few years. If the--the current trend continues with respect to the decline that we've seen historically in solar prices as well as in wind generation prices,

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is there a risk that assets that were financed with the idea, gas assets in particular to be 30 year assets? If--if they should be financed more on a 15 year or shorter timeframe, what's the risk of natural gas generation assets becoming stranded assets in the coming years?

NEWELL: Yeah. So the issue of what--what I would refer to as climate financial risk is an increasingly important conversation, both in the investment community, of course, to, you know, to power producers and energy producers as well. So this is why it's important, I think, to lay out in advance what our future policies will be. Investment unfolds over time. These aren't sudden shocks to the system.

As you alluded to, you know, new investments are made. They--they do last, you know, a significant period of time. They can last, you know, one, two, three decades. But policy also evolves and energy transitions also evolve over the course of years and decades. So these--I don't expect these to be sudden shifts, whether or not there's a kind of stranded assets, that will depend upon if there again, if there's sudden shifts and that investors can't anticipate what kind of cost recovery they'll get on their investments.

HEINRICH: Dr. Birol, in its World Energy Outlook analyses, IEA historically, fairly consistently, under projected both growth trends, and the cost reductions for renewable energy. While analyses. I realize, are based on different policy cases, IEA analyses historically predicted a linear path. But the shifts that we've seen consistently, actually, since the 1970s, on have--have clearly been exponential paths, not linear paths--paths.

And I think this potentially points to the need for a reassessment of the scenarios or assumptions that are used. I know that IEA has made some changes to the WEO over the past couple of years, particularly in 2020. But I was hoping you could speak to those adjustments. What adjustments IEA has made in modeling or assumptions to improve projections of--of renewable energy in the future?

BIROL: Thank you very much, Senator Heinrich. I am very happy that you asked me this question again. So last time, you had to save a question. I--I want to repeat my answer, if I may, what we do is, Mr. Senator, we look at the projections. If the governments do not change the policies, what kind of world we are facing with.

So--which we call our reference scenario or stated policy scenario. And here with the policies governments are putting in place, we have seen a strong penetration of solar and--but the level of solar penetration was not high enough, as much as we would like to see to reach our climate targets. But in addition to that scenario, you might have missed that scenario, which we call the Sustainable Development Scenario, we have seen a huge increase of solar power.

Indeed, only a few months ago, I have the liberty to call solar is the new king of global electricity markets. The reason I said so is that the one--in the year 2020, of all the power plants installed in the world, 50 percent were solar. Other 50 percent, all the other technologies put together namely coal plus oil plus gas plus nuclear plus wind. Hydro 50 percent. Solar 50 percent.

The main reason here is the governments are changing their policies, providing incentives to solar power, and as a result today, as we have suggested our Sustainable Development Scenario, solar power is the cheapest source of electricity generation in many parts of the world. Just for you to note, Mr. Senator, on 18th of May this year, the International Energy Agency will come up world's first roadmap to net zero by 2050.

What will be energy sector? What would that actually look like if the governments around the world take policies in order to reach net zero emissions by 2050, which I expect that the solar power will get the lion's share of the electricity generation, even much higher than what we said before, which is a I believe good news for everybody.

HEINRICH: Thank you, Mr. Chairman.

MANCHIN: Thank you, sir. Thank you, Dr. Birol. Thank you, Senator. Senator Barrasso.

BARRASSO: Senator Manchin, in terms of time constraints, if you'd like to go next, that'd be just fine with me, and I'm happy to stay. I know you have a conflict a little late.

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MANCHIN: I appreciate so much, Senator. And I will and then I'll turn the chair over to you. If--I think this is to Dr. Hsu, I want all of you to think about this right now, the Paris--the Paris Accord and us entering back into the Paris Accord. And my understanding of the Paris Accord is there's different timetables for different participants. And now with things changing since that started where we are today, think about where we are and if we've just all been on a level playing field.

And my question is going to be can United States, can China, can all those in the Paris Accord meet the zero net carbon reduction by 2050? And I'll talk start with Dr. Hsu because of her deep interest in deep involvement in the China energy market. Dr. Hsu?

HSU: Thanks so much, Senator Manchin, for that excellent question. So as you know, the Paris Agreement is formulated on this bottom up process. And so instead of the old Kyoto model, which is what we had in 1992, which--where there are these targets or these timetables that were agreed upon by all parties, the Paris Agreement decided to allow the countries themselves to determine what timetables and targets to meet for their nationally determined contributions, or their MDCS.

And so what the science dictates it provides this broad picture of where we need to go as a world in order to hit these targets of containing global temperature rise within 1.5 degrees Celsius. But the countries themselves can then determine what types of target years and commitments on climate change mitigation, adaptation financing what those look like. So--

MANCHIN: --Don't you think--so if I may interrupt, I'm so sorry.

HSU: No, it's fine, Senator.

MANCHIN: With your knowledge as you have, especially basically with China being one of the greatest emitters. But all of us if we're on that trajectory to hit that and China says they can, can the United States make it? Can China make it? And what--what should we be able to do to make enforcement that other ones, if they're going to say we belong to the Paris Accord, but they're not going to attain any achievements whatsoever in meeting the zero net carbon by 2050? How can we enforce that?

HSU: So that's a really good point. And I think one of the major criticisms of the Paris Agreement is the fact that it's not legally binding. And so because of that, then it's largely up to country governments themselves to implement laws and legislations and to actually implement those--those particular policies to meet their goals.

I think for China, one area and one reason why I have a lot of optimism, and we can see based on their track record that they will meet their Paris Agreement targets is the fact that they have adopted their Paris Agreement goals within their five year plans. And so it's actually codified into binding laws at the very top level and then implemented at the lower provinces. And so I think we can have really a reasonable assurance that China will actually meet their goals, because it's part of their law.

And then the 45(PH)-year plan, which will be released in the next coming weeks, is also expected to incorporate many of these energy and climate targets for the Paris Agreement to help them achieve those goals--their goals. And then also, we should be expecting an enhanced ambition, Paris pledge and NDC, that will also reflect the fact that they have now this longer term 2060 carbon neutrality target. And so it's--but then even still, you're absolutely right, that when you look at the climate models, and the scenarios, all of these Paris pledges that countries have made do not add up to get us to net zero by 2050.

MANCHIN: Right.

HSU: In fact, it's leading to about a 3.6 median degree Celsius warming world by 2100. And currently, we have about a 97 percent probability that we're going to already overshoot to 2 degrees Celsius. So absolutely, the targets and the pledges that are put forth in the Paris Agreement are completely inadequate. So that said, I think that's why it's important and why China's net zero commitment, exactly as Dr. Birol mentioned, many governments are making these net zero pledges and now--

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MANCHIN: --But the bottom--the bottom line with China is they're keeping their own records. I mean, do we know? Do we have insight? Are we able to see factual and make sure that we're getting the correct information? And if I may, you might be real quick on that because I want to ask if anybody else have a comment on this?

HSU: Yeah. I mean, I think that's also a major question. That was an obvious sticking point in the 2009 Copenhagen negotiations where the U.S. really pressed China to open up its climate change and energy data and to have transparency on measurement, reporting, and verification in order to move forward on international climate agreements. I think one of the points that I want to emphasize is that we don't need to rely necessarily on official Chinese statistics and data to have assurance that they are meeting their climate goals.

So for me as a scientist, I use a lot of satellite remote sensing data from U.S. satellites and also from the EU, for example. And we can see, we can observe from space and use that data to see that China actually has been really effective in reducing primarily air pollution and other fossil fuel related--

MANCHIN: --Thank you, Dr. Hsu. I'm so sorry. But I've had to see if any other--if any of our witnesses would have anything to comment on the Paris Accord. How we hold people accountable. Who--who--who's that?

TINKER: Senator--Senator, this is Scott Tinker. Can you hear me?

MANCHIN: Hey, Dr.--Dr. Tinker. Go ahead. Please.

TINKER: Thank you. Yeah, I think it's really important here. And I'll try to be very brief. Look at pledges and then look at results. And--and so if you look at the Paris Accord, the U.S. response to that was the Clean Power Plan. We did not implement it, but that was proposed. We were proposing to reduce by 32 percent our emissions in the power sector by 2030.

We set a self-imposed base here at 20--2005, which was tied to 2007 in the United States for our highest emissions. We met that goal at 32 percent reduction by 2030, non-COVID related, in 2020, 10 years early. So the U.S. reduced 700 million tons of emissions and continues to. How? Replacing oil with natural gas, renewables, solar and wind with the state portfolio standards and other things and efficiency, but also exporting manufacturing.

But doesn't count into the single global atmosphere. That's kind of a shell game. And so how do you really do this? How do you actually reduce CO2 emissions? United States has actually affected change faster than any other country who has pledged. Now, how do we continue to do that globally, I think you're asking. It's a very viable question. And--and part of that comes from across--something can be completely factual, but not factually complete.

I think that's what's happening with LCOE. Yes, solar and wind are the fastest growing sources in capacity and rate, but they're just getting started and everything grows exponentially early. In fact, solar and wind, since 2005 globally, and this comes from the IEA's own data, which are fantastic, by the way, has provided less than 25 percent of the growth in global electricity demand. The growth since 2005. In satisfying--in terawatt hours generated. I'm not talking about capacity.

The actual generation capacity factors matter. So the other 75 percent of that growth was satisfied somewhere else. Natural gas was the fastest growing source of global electricity since 1985 by a lot, and there's reasons for that. But I think as we really converge on the scalability of these global solutions, we can't let--we can't target good fuels. We have to look at what actually reduces at scale emissions compared to things that are being done now. And there are many great opportunities to do that. But we have to be factually complete, not just completely factual.

MANCHIN: Thank you so much. My time has expired. And if y'all want to think about that, if I get a second round, I'll have you all comment at that time. I'm so sorry, but thank you. And with that, Senator Barrasso.

BARRASSO: Thank you so much, Senator Manchin. Mr. Mills, many environmentalists insist that industrialized countries reduce their greenhouse gas emissions principally, if not exclusively, through the use of solar, wind, and electric battery technologies. They often fight you know, coal, natural gas, nuclear power hydro power projects. Can

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you discuss the costs to the environment if these industrialized countries attempt to reduce their emissions principally through solar, wind, and electric battery technologies?

MILLS: Senator, I think that's one of the key issues that is the proverbial elephant in the room. And the IEA and Dr. Birol have mentioned this. Others have mentioned it. The work that I've done is looking at research that comes, in fact, from the UN Environment Program from the IEA, from the World Bank, from academic and research institutes--institutes primarily in Europe, which asks that question what--what is the impact on the environment broadly, not just carbon dioxide emissions.

I--I spoke about carbon dioxide emissions because of a simple fact that, since most of the world's battery materials are processed in China, and as we've heard earlier from witnesses, two-thirds of the grid there is coal fired, that means that the energy to make better materials emits carbon dioxide.

And just as a calibration point, making a battery and the materials for it that can store the amount of energy equal to a barrel of oil requires consuming about 100 barrels of oil equivalent of energy. So that consumption of energy just to build a battery, which doesn't produce energy, but stores it as carbon dioxide emissions. More importantly to your--to your point, it's not just that. It has water use implications, land use implications, toxic mineral management implications because of the processes involved.

In fact, the World Bank issued a report just two years ago, very concerned about what they called a, kind of, and, you know, gold rush for energy minerals in fragile parts of the world, where it's easier to open up mines than in the European and North American continents, specifically because of the need for a whole host of materials, not just the rare earths that are famously or infamously talked about. Rare earths, as you know, are not rare. They have rare properties which are useful, but we don't mine them anymore, significantly.

But it's also nickel and cobalt, very basic materials. The call on copper, which is one of the biggest minerals mined in the world, biggest in terms of quantities. Copper use doubles per car, compare it for electric car compared to a non-electric car, for obvious reasons. It has more electrical equipment in it. Nickel use goes up because of batteries' use of nickel. So the demand for nickel alone, which is not a rare material, goes up literally exponentially in the--in the true exponential sense. It's going to have to come from somewhere. It'll have environmental impacts.

I think we--we will probably not mine it here. I don't see any evidence that the United States is embracing the opening of new mines in a timeframe that will be meaningful. So it'll come from Russia's Norilsk mine in the--in the Arctic, which I'll just note and end on this point for the record, you could say that the world's first oil spill in service of electric cars happened already last year. There was a massive oil spill at the Siberian--Russian Siberian nickel mine. The amount of oil spilled into the Arctic was almost equal to the amount of oil spilled from Exxon Valdez, which was much more infamous and well known. It was the oil stored at the mine site to operate mine equipment. And it caused a lot of angst, and properly so, in the environmental community of Russia.

BARRASSO: So let me ask you this then, Mr. Mills. Last week, President Biden signed an executive order prohibiting new oil, gas, coal leasing and permitting on federal lands and waters. Any reason to believe that that executive order by President Biden is going to reduce the amount of oil and gas that the world will consume?

MILLS: I could make that answer an easy and short one. There's--no, there's no reason to believe that will happen. The world--world's consumption of oil, recovering particularly from the great lockdowns, is going to increase, not decrease.

BARRASSO: So--so is it fair to characterize President Biden's executive order as completely ineffective as a means to address climate change?

MILLS: It's--as a practical means it's utterly ineffective. It will not reduce the consumption of oil or the emissions of carbon dioxide from the combustion of petroleum.

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BARRASSO: So then, is it fair to expect that President Biden's executive order is going to outsource American oil and gas production to tens of thousands of American jobs that come with it to foreign countries, including OPEC members in Russia?

MILLS: The short answer is yes. But it also, by increasing the use of batteries here to offset that oil if it weren't it to be so mandated, we will also export jobs and economic development for that to those nations that make those minerals and materials, as I've outlined.

BARRASSO: Thank you. One question for Dr. Tinker. U.S. carbon dioxide emissions have been steadily declining since 2007. And the International Energy Agency's most recent forecast expects that U.S. emissions to decline by another 17 percent by 2030. Other industrialized countries are also expected to reduce their emissions by 2030.

However, emissions in countries which have been defined as developing countries, and we get into the issue whether that's a good definition or not, they're expected to increase over the next 10 years, in some regions of the world, increase 30 percent in Southeast Asia, increase 27 percent in India, increase 14 percent in Africa. Is it accurate, Dr. Tinker, to say that all the future growth in global emissions is going to come from these, so called, developing countries?

TINKER: It is. And--but there's a reason for that. I think the United States and Western Europe, we built our fundamental economies on coal and oil for transportation and power generation. We've come through a level of wealth now that we're transitioning--and this is national, physically we need to grow, decarbonizing (INAUDIBLE) natural gas, oil and beyond.

And so the emerging and developing world as they grow are also built on coal as an affordable, way more reliable fuel. I don't fault that at all. I think it is lifting their economies from global poverty and creating the products that we all consume. So we've moved our emissions there to keep the stuff we want cheap.

And--and so how do we accelerate? How does--how does China and Southeast Asia and nations that we're following, particularly India--India's just getting started. They passed the United States in coal consumption now, but way behind China. Same, about, number of people. So how does that happen? How can you accelerate into some other baseload dispatchable electricity source in these countries?

And that's really the great challenge before us. I think it's a psychological one. It's an economical one. It's an opportunity for the United States to help lead, in many ways, this effort. So yes, that's where the emissions are coming from. The goal is then to accelerate through that as you balance the energy in the economy and the environmental impacts of that. And it's doable but not if we're not able to support technologically and economically and with leadership in the United States for that to happen.

BARRASSO: So--so if we want to help these developing countries reduce their emissions, would you agree that the United States should really develop technologies to lower emissions that we can then export these technologies so they would be used in these other locations around the world?

TINKER: Technologies and energies. I've done--I've been--visited China many, many, many times throughout the last couple of decades and done work there looking at their shale opportunities for natural gas. And other--and they have natural gas resources but it's not at the level of those exist in Russia, as already been mentioned, et cetera. LNG could bring some of that natural gas in as options in addition to the nuclear their developing, the hydro and the solar and the wind.

So its resources as well as technology. The United States leads in--in environmentally adept ways to develop oil and gas. Oil and gas isn't clean. Nobody ever said it was. Nothing is. No form of energy is. But we are leading in that. And so how do you accelerate and bring those technologies into the world such that they can skip the steps we went through to get to the high density, really, and the high volume extraction from a very small surface, kind of minimizing use of water and other kinds of things that need to happen with the extraction of fluids from the Earth. By the way, those are much more extreme in might (INAUDIBLE)--

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BARRASSO: --Thank you--

TINKER: (INAUDIBLE)

BARRASSO: --Thank you, Dr. Tinker. We're have a little bit of technical problem with a--with feedback. Let me turn to Senator Hirono.

HIRONO: This is for Dr. Birol. In your testimony, you highlight the need for ambitious actions--

BARRASSO: --Could you--could you--could you wait--give us one second? We're having a hard time getting the volume up. I can kind of hear you--

HIRONO: --All right--

BARRASSO: --But we--but the rest of the--rest of the folks cannot.

HIRONO: Okay.

BARRASSO: It might be on--oh, they're telling me it might be--it might be on your end.

HIRONO: Really?

BARRASSO: Now, It's better--

HIRONO: (INAUDIBLE)

BARRASSO: It's better. Much better. You--get closer to the microphone, perhaps. Please, proceed.

HIRONO: Shall I start again, then? For--this is for Dr. Birol. In your testimony, you highlight the need for ambitious actions and note that almost half of the emission reductions needed to reach net zero by 2050 will need to come from technologies that have not reached the market today. You note the importance of American leadership. And, as you know, American leadership on clean energy is a priority for President Biden. What kind of ambitious incentives or mandates do you think the U.S. needs to put in place within the next year or two to remain a leader in emission reductions and clean energy technologies, Dr. Birol--

BIROL: --Thank you. Thank you very much, Senator Hirono. This is an extremely important fact. In fact, a senator mentioned the Paris question. And this is very much linked to the Paris question, how to reach the emission reductions, huge emission reductions in 2050 to net zero emissions. So we have--we need three things here. One, to make the most out of the existing clean energy technologies. What are those? Renewables, efficiency, nuclear power. These are the key ones. But these are, as you said, Senator Hirono, these are not enough to make the emissions come to net zero by 2050.

HIRONO: Right.

BIROL: As our analysis show, the half of this emission reductions need to come from technologies which are not in the market yet.

HIRONO: Yes.

BIROL: Therefore, the key word is innovation. What are those? For me, a critical one, perhaps the most critical one, is carbon capture utilization and storage. It's an extremely important one looking at the current energy infrastructure, we have around today. Second, advanced nuclear power. Third, hydrogen. Fourth, the batteries, advanced batteries.

And when I look at the history of the United States, the innovation is in the DNA of the U.S. energy industry, in fact, U.S. industry in general. When we look at the internet, when we pick the chips, United States was the--the forefront. So my expectation is, United States, not only at home but it can shows the leadership to push this clean energy

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technologies, which are not in place yet but very important for the future. You have (INAUDIBLE) wonderful laboratories across the country and they can play a critical role here--

HIRONO: --Yes--

BIROL: --In my view.

HIRONO: Dr. Birol, the question was, what, you know, what kind of mandates or incentives? Because I know we're doing things with battery development, for example, but, you know, are there ways that we can incentivize the commitment to moving into those innovative areas that you're talking about? But let me just ask one more thing, though. You talked about using existing technologies. And one action that we can take today, using technologies that are already on the market, is a lower methane emissions--to lower methane emissions from oil and gas wells.

And on January 2012, the NEA--IEA, sorry, report noted, reducing methane emissions from oil and gas operations is among the most cost effective and impactful actions that governments can take to achieve global climate goals. However, the report knows that while reducing methane emissions may be cost effective, many companies are not voluntarily doing so. There was, at one time, a federal methane regulation on the books to require companies to detect and reduce methane leaks. And the Trump administration repealed it last year. So how important do you think it is the U.S. resume regulating methane emissions, being very cost effective on other ways that we can use existing technology, for the oil and gas industry? Should we reassert that regulatory requirement?

BIROL: Thank you very much, Senator. First of all, coming back to your first question, incentives for the--a clean energy technologies, which are not in the market here, it can be many ways. For example, this committee--your committee has a for the CCS, 45Q tax credits, it was an excellent move in the right direction. And also, the economic recovery packages which will be coming soon, I hope they will provide incentives for the clean energy technologies. Plus, the research and development budget for these technologies can be increased and some mandates can be deployed in order to give a strong push to clean energy technologies, which are not in the market yet.

Now methane, thank you very much for referring to our report, methane is a powerful greenhouse gas. And especially is so and when we'll look at the world, we said for the CO2 emissions, China is the number one country, but for the methane. United States is number one country in terms of methane emissions, followed closely by Russia. And the methane emissions reduction is not rocket science. You need to have the right regulations in place in order to minimize the venting and flaring.

And methane is (INAUDIBLE)--is a price--is the price of natural gas. What you need for this is to put the right policies and monetary framework. And the--I know that many companies are already making some efforts, but it's a major issue for the United States and many other governments, including Russia and other Middle East countries to address this issue. Our analysis show that the big chunk of the methane emission reductions are, as you mentioned, cost effective and--they're--some of them are in the negative cost.

HIRONO: Thank you very much. Thank you, Mr. Chairman.

BARRASSO: Thank you, Senator Hirono. Now we have Senator Cassidy.

CASSIDY: Thank you, Mr. Chairman and Mr. Ranking Member. Dr. Mills, there was a good exchange you had with Dr. Barrasso. But I just want to make it clear. When we, potentially, don't develop our oil and gas, we will shift production of the oil and gas to other countries with lower environmental standards, which is to say, per unit of oil or gas produced, there'll be more greenhouse gases emitted into the atmosphere. Is that a fair statement?

MILLS: If their environmental standards are lower, it'll be higher--

CASSIDY: --I cannot hear you very well--

MILLS: --Right--

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CASSIDY: --Is that me or you--

MILLS: --Right. Pardon me?

CASSIDY: I can't hear you very well--

BARRASSO: --Yeah, I think that's on your end, Bill.

CASSIDY: Okay.

BARRASSO: Because we can hear him pretty well--we can hear him wonderfully in the committee room.

CASSIDY: Okay, please proceed.

MILLS: The efficiency from a carbon dioxide perspective is typically lower--it--in other oil drilling provinces. But the issue I was referring to are other environmental features, water use, water contamination spillage, labor practices, the whole panoply of environmental issues about which we are, in--in America in particular, very cautious. Many nations aren't as cautious as we are. But your question about the carbon dioxide efficiency of primary energy extraction is, as I said in my testimony, is actually rather complex.

The issue is not that--isn't some energy used to produce energy--minerals, including oil, but who produces it because we'll--we'll--the world will use more oil in the future than it is in the present for the near foreseeable future, decade or two, at least? If we don't produce it, your point is absolutely correct. Others will. And it's not complicated to figure out who they are.

CASSIDY: Yes, I see that. And--and you point out Russia. And we've seen the methane emissions increase from Russia. And so presumably, if they took over gas production, that you would continue to see that increase methane from Russia. Granted, I think, Senator Hirono points out wisely that we need to decrease ours. But I have more faith in us making that commitment than I do in Russia.

Mr. Newell, in your response to Senator Heinrich, you spoke of the levelized cost of electricity. But it's fair to say that that levelized cost of electricity for wind does not include the backup plants needed to address the intermittency of the wind and--and the base load that would be required to run concomitantly. Is that--is that true?

NEWELL: Senator, yes. You know, one of the--

CASSIDY: --I have another question. I have limited time. Is that--is that--

NEWELL: --Yeah, one of the inadequacies of the concept of levelized cost is that it doesn't directly address intermittency of different resources, and so that you make a--a--good--

CASSIDY: --Okay. So let me ask you another question because I have a limited time.

NEWELL: Yeah--

CASSIDY: --What I don't know--does it also--does the price that is quoted for wind, is that a net of the federal subsidy that goes for the production tax credit or whatever is used? So it's not the true production cost. It is a production cost minus the subsidy. Is that correct?

NEWELL: That's not correct, Senator. So the--the--this--the costs that I cited do not include the subsidies. If you include federal tax incentives or state level renewable portfolio support that would further reduce the cost. They've--they've come down in real costs, aside from tax credits and other support policies.

CASSIDY: Thank you very much. Dr. Birol, really enjoy--I always enjoy your testimony, and enjoy all of your testimonies. You mentioned the reliable supplies are critical minerals and metals vital to energy transitions. I don't know this answer, but I've read that there's actually not enough cobalt in the world to completely go to an all-electric vehicle standard. Is--is--is that true, or am I misunderstanding that?

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BIROL: Thank you very much, Senator. As I said, a few minutes ago, we are looking at the impact of the ambitious climate policies and the availability of critical minerals in the next 10 to 20 years or so. And we are going to release this report in April. If you wish to, I will be very happy to report to your committee what the results are, what intentions are. But currently, it is not a major issue. But with increasing demand, there may be clashes of supply and demand, number one.

Second, this may have implications on the process. And third, this can also lead, in some cases, some energy security implications. But these are not issues that cannot be addressed. Can be addressed through different trading partners, having reliable trading partners, putting international standards, and finding substitutes to those critical minerals. But as I said, we will come up with our report in April to show where the stress points are, what are the implications for the governments who are pushing clean energy transitions for their economies and for the energy security.

CASSIDY: I look forward to that report. Thank you. And I yield back. Thank you.

BIROL: Thank you.

MANCHIN: Thank you, Senator. And now we have Senator King.

KING: Mr. Chairman, we've been talking a lot today about the cost of transition to a new lower carbon economy. I have a couple of slides--several slides I'd like to share that put this into perspective of the cost of not making this transition, if the--if the tech people can put up the first slide for me. What this is--is several hundred thousand years of CO₂ in the atmosphere. Many people talk about natural variations, and as you can see from this chart, there are natural variations. But if you look at the far right side of the chart, we're way outside of those natural variations. We're well above, now, 400 parts per million of CO₂.

This is a vivid demonstration of the fact that we're in uncharted territory. In fact, it's not really uncharted. 3 million years ago was the last time we had 400 parts per million. And, by the way, the oceans were about 60 feet higher. So speaking of the oceans, if you can put up chart number two, this is a really fascinating piece of data. This is 24,000 years of history. And the low point on the left is the--the height of the Ice Age. It was when a huge amount of water was locked up in the glaciers. And what you see is the increasing depth of the ocean, it's about 390 feet of difference between 24,000 years ago and today.

There are two important things I want to point out on this chart. You'll see in the middle, there's a very steep incline of increasing water depth, called meltwater pulse 1A. The reason that's significant is that during that period, the ocean level rose a foot a decade. And many scientists believe that we're in a similar moment right now. The point I'm trying to make is, this is not science fiction. This has happened in the past.

And the other interesting thing about this chart is, if you go over to the right where you see it sort of levels off at the top, that's the current sea level. It's about the last 8,000 years. 8,000 years happens to be recorded human history. In other words, the oceans have been where they are. And we all think of them as being constant. The point of this chart is that in fairly recent times, 25,000 years, they haven't been constant at all. The Chesapeake Bay 15,000 years ago, was a nice river valley of the Susquehanna River. It was mostly dry land. So the whole East Coast would move about 180 miles east 15,000, 20,000 years ago during the Ice Age.

Here's the third chart, which talks about the practical effects of what we're looking at. This is ice concentration in the--in the Arctic. It's reduced by 75 percent in the last 40 years. The point I'm making is, we're talking a lot today about the cost of transition. We also have to talk about the cost of not transitioning and the dramatic impacts that we're facing.

You want to rebuild Miami or New Orleans or New York, Washington D.C. or any--any coastal communities, if we're talking about six to eight feet of sea level rise in the next century. That is a catastrophe, both a human catastrophe and an economic catastrophe. So I just wanted to--we're talking about baseline in this--in this hearing. And I wanted to talk about the fact that we are in a very, very dangerous time and facing, what I think, is--could be catastrophic changes, if not within our lifetime, certainly within the lifetime of our children and grandchildren.

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A couple of questions. Dr. Hsu, and John Barrasso--Senator Barrasso mentioned this, given the magnitude of this problem and the fact that it is an international problem and that there are developing countries that don't have the technological and industrial base that we have, wouldn't--wouldn't a good adjunct to the--to the climate--the Paris Climate Agreement be technology sharing? This should be an international moonshot, if you will, to develop the technologies both for efficiency and for carbon-free production. Dr. Hsu, is that something we should be--be working on? Bearing in mind, I've already used a lot of my time but give me a couple of sentences on that, please.

HSU: Yes. I absolutely agree with you. Thank you for the question. But I also think it's not just about technology sharing but--and cooperation, but it's also about competition. We can also compete as the U.S. in promoting clean technologies abroad and accessing markets that are now growing in their demand for clean technology because of their decarbonization goals and their targets under the Paris Agreement. So I think that there is even more opportunity for green competition as well and not just technology sharing.

KING: Great. Mr. Mills, I want to understand your testimony. You're talking about the costs of building batteries, for example, and I understand there's--their environmental cost, there's no free lunch in energy. I learned that a long time ago. However, are you saying that the emissions that go into the manufacturing of--of a single car battery would be equal to the emission saved by that car battery and an electric car over, say, 150,000 miles of a 10 year life? Are you--is that--are you--I don't think--I hope--I don't think you're saying that, but I just want to be sure.

MILLS: Senator, thanks for the question. I am saying that. And in fact, there's very robust studies on this. I was not speaking to the economic costs because the baseline, I believe we were talking about, were emissions. I was pointing out that the emissions associated with the energy consumed to fabricate batteries to make and process the key (INAUDIBLE) promoted by advocates of--of either forms of energy. The analysis of what is involved in the fuel cycle to make the battery--battery materials, the range of energy cost--energy costs, not dollar costs, to fabricate a barrels' oil equivalent of energy storage consumes 1 to 300 barrels of oil--of energy to fabricate that quantity of batteries. So that--that is correct--

KING: --But my question is, how many barrels of oil would be offset by that battery over a 10 year life--

MILLS: --That--that's a very fair question. It does--it offsets over its life. Oil depends on where the cars exist. So in the world that exists today, batteries that are fabricated with those--the way we now do it would result in emissions that are only partly offset depending on where they're driven.

One of the European studies finds if you drive the Tesla in Norway, for example, half of the emissions savings you have by not burning oil are wiped out by making the electric car. If you drive the vehicle in most of Germany, two thirds of all the emission savings are wiped out. And if you drive it in Poland, obviously they have an electric grid that's coal fired, then you have net increase in emissions. So yes, I was saying exactly that. That's what--what needs to be part of the accounting--

KING: --Well, I'd appreciate if you could supply those studies for--for the record, for the committee. I'd be very interested in following up.

MILLS: Yes, sir--

KING: --One final comment, not a question. I know my time is up. I want to associate myself with Senator Hirono. The low hanging fruit of climate change prevention is methane. And most of the methane comes from unregulated oil and gas drilling, whether it's in Russia or here. I think that's an area where we need to lead. But we also could be talking to Russia about some kind of methane treaty, if you will, because it's cost effective. We ought to be doing it and it's, by far, the easiest, shortest, and most cost-effective way to deal with--with climate change. So thank you. Thank you, Mr. Chairman.

MANCHIN: Thank you, Senator. Next, we have Senator Daines.

DAINES: Thanks, Mr. Chairman. Since President Biden took office just two weeks ago, we've seen attack after attack on made-in-America energy and union jobs. And we know how devastating this will be to Montana's

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economy, Montana families, the reliability of our electric grid. Just look at what California went through last summer as it relates to what happens when we take radical shifts to the left, and the lack of reliability that comes from--from those shifts. These actions could actually move us away from our climate ambitions.

Today, the United States leads the world in reducing energy related carbon emissions. We're number one. We've achieved this through innovation, not regulation. However, a recent report found that President Biden's ban on federal energy leasing will lead to a five and a half percent increase in carbon emissions in the power sector by 2030. The cancellation of the Keystone XL pipeline, which has undergone extensive environmental reviews and would have achieved net zero emissions by 2023, will force major quantities of crude oil onto the rails, which now will emit up to 3 million tons of carbon dioxide annually into the atmosphere.

Let me say that again. The cancellation of the Keystone XL pipeline could lead to an increase of 3 million tons of carbon dioxide emissions per year. By the way, any ban on fracking is also expected to drastically increase emissions. I'm a chemical engineer by degree. I like to look at the numbers. The science tells us that these radical moves to the left are actually going to increase CO₂, not decrease CO₂. Mr. Mills, has technological breakthroughs like the horizontal drilling and hydraulic fracturing lowered our emissions? And do you believe that heavy handed regulatory approaches, like the executive actions seen over the past two weeks, actually move us away from emission reduction goals?

MILLS: Well, thank you, Senator, for the question. Chemical engineering is one of the disciplines I respect enormously as a physicist. I--I took--chose physics because chemistry was hard. So the answer is yes, of course. The--the hydraulic fracturing in the United States is so productive and so economically responsive. It's fast, which is non-trivial in capital markets, that it drove world prices of gas down, drove down domestic prices. And, as most analysts know, the principal reason for the reduction in coal use in America is because gas got so cheap. So it--it is a profound impact globally. There is certainly a path to tremendous improvements yet in those markets in terms of economic and resource efficiency.

DAINES: Thank you very much. Just last week during a press briefing, one of the president Biden's top aides, Gina McCarthy stated and I quote, "Climate change is the most significant public health challenge of our time." Let me just state the obvious, we're in the midst of a global pandemic so I'd have to say this is certainly not the case. It was also not the case before the pandemic hit. The greatest indicator of health status is poverty and access to reliable affordable electricity, which usually provides clean water. That's intrinsically linked to human welfare.

The policies initiated over the past two weeks which are being pushed by the left, only compromise energy access and jobs, which will now exacerbate the health and economic crisis that we are in now. They will lead to higher energy costs, higher gas prices for Americans at a time when families are struggling to make ends meet and keep food on the table. As shown by the U.S. reduction in emissions, it is possible to grow our economy and specifically our energy sector while meeting our environmental goals. In fact, in 2019, energy related emissions fell by 2.6 percent in the U.S. Meanwhile, China increased their emissions by nearly twice as much. Dr. Birol, can you speak to how us carbon emission reductions compare to countries like China and India?

BIROL: Thank you, Mr. Senator. You are right. In fact, in the last decade or so, U.S. emissions declined significantly, mainly as a result of natural gas replacing coal but also big push for--of renewables, solar, and wind. These were the main--two main reasons. And today, U.S. emissions are half of that of China, globally. China is about 30 percent of the global emissions. United States, 14 percent. Having said that, if you look at it, because people look at the emissions indicators from different angles, the U.S. per capita emissions is one of the highest in the world, much higher than China. And I would like to say that the--I also see--I like very much the Mr. Kings' graphs of what would happen if we don't act.

In addition to those--the--the implications on the climate change, I can tell you that if U.S. do not act, push the clean energy transitions, U.S. industry, U.S. technology may be well beyond the curve. Others are moving. It's not only a policy but also market driven transition. Therefore, U.S. is always the leader of innovation, new technologies. And I believe, while U.S. preserve this important, strong cause in the global energy markets, pushing innovation would be

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also an economic idea in addition to playing an important role responsibly as a leader of the international community.

DAINES: Thank you, Dr. Birol. I'm out of time but let me just say this. In Montana, we have the nation's largest reserve of recoverable--recoverable coal and large-scale coal plants. We are uniquely positioned in Montana, speaking of innovation, to be a leader in carbon capture research and development. 35 percent of carbon emissions reductions have already been achieved these high efficiency, low emissions coal plants. So I'm--I'm all--all about innovation. We've got some great ways to do that in Montana. Mr. Chairman, thank you.

MANCHIN: Thank you, Senator. And now we have Senator Cortez Masto.

CORTEZ MASTO: Thank you, Mr. Chairman. Thank you for this conversation. This has been a fantastic conversation. And as always, I always learn something from my good friend and Senator from Maine, Senator King, who I've always enjoyed listening to and his questions. But I--he nailed it for me. And this is why I think it's so important to have this discussion. The really--I have been hearing the discussion, here, about the cost of transition versus the cost of not transitioning. But we have not talked about the benefits of transitioning.

Here has been my concern all along as I sit in for the last four years of the Senate is, I have watched China take advantage economically over the United States and other countries. And they're still pursuing that. They are investing billions of dollars. This is an area we, now, as the United States, when it comes to clean technology, have the ability to lead if we actually invest in the research, the development, and the deployment, because whoever can lead in this clean technology, whatever country has the best technology is going to have a better economic advantage moving forward. And we are transitioning no matter what anybody says.

So I'm going to stop preaching. But let me just say this, and I'm going to ask both Dr. Hsu and Dr. Birol. You know, part of the conversation that I think is important for the Paris Agreement is not whether there's an enforcement, not whether we can ensure, you know, their carbon reduction, it is the fact that we are trying to achieve a goal, here, and incentivizing all of our states, all of our private sector, all of our government to work together to go down the path towards this clean energy and develop this new technology, because this will create jobs.

This will give us an economic advantage. And other countries will want to be understanding as well or possibly be able to engage in that. Is that correct? What are the benefits for us entering into the Paris Agreement? And Dr. Hsu, let me let me ask you.

HSU: That's a great question. And thank you so much, Senator, for asking it. You're absolutely right. If we look at China two decades ago, it basically didn't even have a clean energy sector to really speak of. And then, because of that massive amount of investment, they were able to, basically, eat all other countries' lunch when it comes to producing solar wind turbines, for example. I think I stated in my testimony that two thirds of all wind turbines are coming from China. Half of all solar panels are produced in China. So there's a huge market out there for these technologies.

Some estimates that I've seen predict that by 2030, there's going to be a \$23 trillion market for climate smart investments. And so this will just continue to grow as countries, exactly as you said, work to meet the goals of the Paris Agreement. So yeah, I think, absolutely by sticking to these old fossil fuel-based industries that our economy has relied on to achieve the emissions reductions in the past decade, I think it's short sighted. I think the world is moving in the direction of decarbonization. And if the U.S. doesn't act quickly and decisively enough, they're going to miss an opportunity. Thank you.

CORTEZ MASTO: Yeah. And with that said, I do understand. Listen, China is trying to decarbonize by 2060. But we also know China's continuing to invest in fossil fuels from emerging countries--in emerging countries, right? So--so we know that our--the emerging countries, right now, are challenged, and they're--they're going to be transitioning.

But right now, they're looking for the lowest cost. So it does make sense for us to--to work to figure out how we develop this technology for carbon capture utilization and storage, and how we address the methane gas because it's not going to go away anytime soon. And nor should we look to put people out of work, right?

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We want to transition to the jobs. We want to transition to the technology, the jobs of the future, and transition those skills along the way. Everybody should be employed. With that said, let me ask Dr. Birol. For purposes of the Paris Agreement, you talked a little bit about the benefits of it, renewables, efficiency, nuclear power, advanced nuclear power. And--and you talked a little bit about incentives that the United States can engage in, including tax credits, as well as research development and deployment. What else should we be doing to ensure that we are incentivizing across the states in this space to develop the technology that's necessary for this clean energy?

BIROL: I take a--a-if I may, Madam Senator, combine this question with your wonderful comments about the competition is very important, here, between the countries to develop the clean energy technologies. One lesson for the United States from history, we all agree, today, that is solar is one of the cheapest sources of electricity generation.

And it was United States which put, between 1975 and 2000, U.S. federal government subsidies, about \$3 billion, in order to bring the cost of solar down, year '75 to 2000. And afterwards, perhaps, if I may say so, dropped the ball. And today, when we look at the picture, only 1 percent of the solar PV module shipments come from United States. And 7 out of 10 solar PV is coming from Asia.

So I think we need to learn from this example what kind of incentives, it can be tax incentives, it can be subsidies, mandates, and some, in my view, some standards are needed. You talk about the methane. Methane--to capture methane, is a, really, an easy business. It is for--the many companies, they just don't need to be greedy. They just need to put additional technical equipments, reducing venting and flaring, which is--which will happen only and only if there are regulations there. In my view, strict regulation method is a part of the incentives, if I may say so.

Finally, Madam Senator, even if there was no climate change concern, if we said that there was no climate change concern, I still believe that the United States would still push the advanced technologies to be a leader in the global economy, because the right is going. And today, if many car manufacturers are changing their strategies, portfolios, and pushing the electric vehicles, it is not only--only to save the planet but is also putting their businesses--their strategies in the right track to make money for themselves and for their shareholders.

CORTEZ MASTO: Thank you. And, Mr. Chairman, thank you. I know my time is up. But let me just say this, this is our moonshot. This is it. In this century, this is what we have to tackle. And--and I come from a mining state, I am very proud of--of the mining that we have. We have the ability to create new jobs around the critical minerals that are really necessary for this clean energy, from the extraction to the production all the way to the end product.

And we should be doing that. We should be engaging on how we continue to develop these new technologies from out of the ground to--to the finished product because that is good for our economy, it's good for jobs, and it gives us that competitive advantage that I would like to see the United States lead with. So thank you.

MANCHIN: Thank you, Senator. Senator Hoeven? Has Senator Hoeven been able to get back? If not, we'll go for a quick second round. Anybody that might have--I have one to finish up on--

TINKER: --Mr. Chairman, this is Scott Tinker. Is my microphone working now?

MANCHIN: It is now. Yes.

TINKER: Okay. I apologize. I--not sure what happened there--

MANCHIN: --There's a little bit (INAUDIBLE) before but--

TINKER: --Certainly have a lot to--a lot to share on each of these topics.

MANCHIN: Okay, Scott, we'll get back to you. I want to--anybody that didn't have a chance to respond to my first question, if you recall, on the Paris Accord, where we're going, different times, different elements, different people may--different countries meaning different timetables, and if--and hitting the zero net by 2050. Yes, sir, Doctor.

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NEWELL: Yes, Senator. One of the things to recognize is that the concept of net zero and why has that gotten so much salience. And the reason is that when carbon dioxide emissions are put into the--into the climate system, they let--they stay there for 1,000 years, right? They don't go away. And so the concept of net zero is that if we want to stabilize the climate and stop temperature from rising, we need to get to net zero emissions to stabilize the stock of greenhouse gases in the atmosphere.

So that's the--it's a very simple concept. And it's--it's, you know, it's got an increased policy salience. Now, the United States, and this has come up before, the United States we're--we contribute about 15 percent of global greenhouse gas emissions. That means 85 percent is coming from other countries.

And so how do we prevent the impacts on the United States in our own self-interest from climate change? How do we prevent additional sea level rise and temperature change? We need to do that both are our own actions, and very importantly, by encouraging actions by other countries, because 85 percent of the impacts we're feeling are actually coming from other countries.

So how do we do that? We have to engage in international agreements like the Paris Agreement. And I think in order for us to expect other countries to react in kind, we need to lead by example. So that's what I would say, Senator. Finally, in terms of, you know, particular net zero goals, in order to stabilize the climate, I would think we need to get to net zero as quickly as possible. Exactly when that is--is going to depend on how technologies fault (PH), how policies unfold, how market conditions change. I guess I finally (INAUDIBLE)--

MANCHIN: --There's nothing enforcement about the Paris Accord. That's the problem. There's nothing enforcing it whatsoever.

NEWELL: What--the Paris Accord is based, as was described earlier, on bottom up commitments by countries.

MANCHIN: Okay. And Dr.--Dr. Tinker, I don't think you've commented on this. Am I right?

TINKER: I haven't--

MANCHIN: --I know Hsu has--

TINKER: --Or maybe I did but you didn't hear me--

MANCHIN: --Dr. Tinker, please--Yes, we got you. We got you, Doctor.

TINKER: Thank you. I probably was talking to myself. But no. Thank you. Yeah, I think it's really important on the accord optionality. So replacing CO2 dense emissions with less dense and--and you got to think about those that are intermittent and those that are base loadable. So replacing coal with natural gas has had a huge effect in the United States.

Capturing the CO2 from that natural gas would have an even more effect. And then, supplementing that with other things. I think the--the levelized cost conversation, which didn't come through, we have to be complete on that. Again, when you have to backup materials, backup intermittent energy with--with something, and it's 100 percent backup plus or minus, and batteries are redundant plants, that--that raises the cost.

It really, Dr. Birol, knows this very well, that the levelized cost does not represent the cost to the consumer. It doesn't. That's why California in the northeast U.S. and Germany pay so much more for electricity, today. The consumer does. It's regressive.

And it's not--it's just physics and economics. You have to back intermittent energy up if you want steady electricity. So we have to be--we have to look at the complete cost of electricity. Density matters. A lot of stuff--I definitely respect and am very close with the state geologists in Nevada. And mining, it is important. We have to think candidly about how much mining we will enable here. If we're going to manufacture stuff here, where does it come from?

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I've put solar in--in--in Colombia, in our film, Switch On, a film on energy poverty, and--and--and it takes stuff from all over the world to do that, to--to bring it to it, manufacture it and deploy it. The production chains for this are phenomenal. So how are we--how are we going to accomplish that globally to truly reduce emissions in our real world, in a real world where others are making most of our stuff, now, in this country? That's--it's such a practical question. And--

MANCHIN: --Doctor, I hate to--

TINKER: --Yeah--

MANCHIN: --I hate to cut you short, Doctor. I've got two other--

TINKER: --Okay. Sure--

MANCHIN: --If you don't mind--

TINKER: --You bet--

MANCHIN: --We'll get back. So I will--I'm going to go to Mr. Mills. And then, we're going to finish up with Dr. Birol real quick. I'm sorry to indulge, but we want to get these out. Mr. Mills.

MILLS: Thank you, Senator. I'll--I'll--I'll--I'll take you at your word and answer the question about what do I think about the probability of reaching that goal by 2050? If I were willing--if I were betting, and I'll take the public bet, we won't reach the goal. And I know the states are all--

MANCHIN: (INAUDIBLE)

MILLS: --Neither the United States or the world. And I say that not because it's aspirational and it should or shouldn't, aside from that entirely. The inertia in these systems of the world are--is so great, and the magnitude of the resources that we have to put the work is so large that it would require efforts that are equivalent to a World War II type of mobilization, not just for a few years but for decades.

The physical resource requirements, and I'm looking forward to the IEA study on this, I suspect will look like other World Bank and IMF studies, are astonishing. I just don't think the world is prepared to mine that much material, move that much material, and spend that much capital. So I would bet against it happening. So that would argue that we have to start thinking seriously, as some organizations do, about resilience and adaptation to whatever--whatever happens to the climate in the coming decades.

MANCHIN: Thank you. And Dr. Birol?

BIROL: Thank you very much, Mr. Manchin. So I wouldn't bet either way. We are going to, as I said, making a study on 18th of May. We are publishing to see what needs to be done to reach net zero by 2050. And I can tell you that it requires Herculean efforts to reach the major transformation of the energy sector around the world. And one key word here, there are many, many challenges, but one important challenge, in my view, is the--there is a need for international collaboration amongst the countries around the world. This is the biggest challenge. And if we don't come together, it will be very difficult to reach this target.

And here, yet, finally, one opportunity. Many countries around the world, including the United States, are putting economic recovery packages. Once in a--once in generation scale of--trillions of dollars. And many governments are putting incentives for the clean energy technologies. This can well create an unprecedented momentum for deploying technologies and can give a strong support to reach those targets. But once again, it requires Herculean efforts to reach those targets, which I believe from the pictures of Mr. King is (INAUDIBLE) for all of us to reach. Thank you.

MANCHIN: Thank you, Dr. Birol. What we have--we have Senator Hoeven. And then, Senator Barrasso will finish up with a second round. Senator Hoeven?

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HOEVEN: Thank you, Mr. Chairman. I appreciate very much. Dr. Birol, when you appeared before us earlier, you talked about the importance, in terms of fossil fuels, coal fired electric plants, providing a substantial amount of energy throughout the world. And that's going to continue to be the case. And then, emphasized that carbon capture and storage--now, you called not just one of the most important technologies, but the most important technology that exists because of its ability to marry the benefits of good environmental stewardship and continued dependable energy production.

So, I guess, my first question is, do you stand by that statement? Is CCUS indispensable in terms of making sure we have dependable low-cost energy and meeting our, you know, objectives in terms of reduction of CO2 emissions?

BIROL: Even more than before, Mr. Senator. It is getting more and more important, more and more critical, CCUS, in power generation, industry and (INAUDIBLE). The problem is not energy. The problem is emissions. Energy is good. Emissions are bad.

HOEVEN: Right, but--and so that--isn't--isn't the demand for fossil fuels, coal fired electric production going to continue, particularly in a lot of countries outside the United States, and so isn't cracking the code in terms of making CCUS commercially viable, which we can do here with our technology, isn't that vitally important, not just for us, but--but really, for the world?

BIROL: Very much so. I think it will be not only important for the new power plants to be built but also with the existing power plants today. One third of the--all the emissions in the world come from the coal fired power plants around the world. And if the United States was a leader of the carbon capture utilization and storage technologies, and it can very--be a very important product for export exporting that technology around the world. And this is what I would expect from the United States.

HOEVEN: So we've worked on things and--so we're trying to make that happen. Thank you for your comments. And I agree with you. And we're working hard to make that happen. We've worked hard to get 45Q in place. So my question is, what kind of enhancements--and we're working on funding from the Department of Energy, loan guarantees--what else can we do, should we do, to make this happen? How do we help, you know, make this happen in the United States, lead the way forward, deploy it commercially, advance the technology, and really lead the world here? What kind of things can we do to help make that happen?

BIROL: When I look at the numbers, 45Q seems to be working. We have seen several new projects coming in line. Maybe expansion of 45Q and maybe, a--providing additional incentives for the--especially for the industrial sector, cement, Eisenstein (PH), and others--had to push the CCUS technologies and as such, bringing the cost down. Today, the issue is not with whether or not technology works, issue is the cost of the technology. We just need to bring the cost down. As we have seen in the solar, by--learning by doing, we brought the cost down. And the CCUS may well hit the same pattern if there was a leadership (INAUDIBLE).

HOEVEN: So those will be the keys: enhancement of 45Q, help through Department of Energy and other sources to--for the front end cost to put this technology on the plants, and then, loan guarantees to help those companies actually finance their costs to not only advance the technology but to put it into place and operate on a commercially viable basis. Those would be--you think would be the keys (INAUDIBLE) to happen instead of just talk about it, then we've got to work with our Department of Energy and our companies to do those things, you would say.

BIROL: Yes, definitely. Especially now, focus need to be in the industry sector as well, either steel, cement and other petrochemical industry. And we are going to--we are--we'll be working with the Department of Energy in order to provide them some assistance.

HOEVEN: And you think that could have a huge impact for our country and that we could really lead the world forward in (INAUDIBLE). Correct?

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BIROL: Definitely. And the United States can be the leader of this technology around the world, and as such, not only benefits the U.S. economy, but in terms of reducing the emissions, chipping the energy in the United States, but also exporting this technology around the world.

HOEVEN: And a lot of great jobs, right?

BIROL: Yes. Exactly. CCUS a job--CCUS a job creating machine.

TINKER: Senator Hoeven?

HOEVEN: Thank you very much, Doctor. And thank you, Mr. Chairman, I appreciate--

TINKER: --Senator Hoeven, just briefly, geology matters with CCUS as well, so the--the ability to put fluids in it rate and in the volumes. And there again, the United States has a remarkable advantage. The Gulf of Mexico, where infrastructure exists and--and sites to capture, and then, owned by the federal government and the states in the offshore, is a remarkable site for large scale CCUS that could be world leading in setting up a hub for capture, transmission, disposal and monitor and verifying its storage. 50 Gigatons potential storage there. So we have a remarkable opportunity to lead that. But the geology does matter.

HOEVEN: Thank you, Dr. Ticker. Appreciate that very much. And again, thank you, Mr. Chairman.

MANCHIN: Senator Barrasso.

BARRASSO: Thank you, Mr. Chairman. Dr. Tinker, China is the world's largest emitter of carbon dioxide. And it accounts for about 30 percent of global emissions. So while Chinese emissions have been rising for decades, U.S. emissions, as we've talked previously, have been steadily declining since back in 2007, and expected decline another 17 percent by 2030. So in 2015, China said they're going to cap their emissions by 2030, so 2015 all the way up through 2030. Is it--is it fair to say that China's pledge is really just business as usual for them?

TINKER: Well, it's interesting. Yes, in some senses. But business as usual is really transition as usual. Nothing is static. So the transition in fuels is very real. China is transitioning, it's growing its economy on coal, but we'll transition away from that. So it--it is business as usual in that transition.

Accelerating through that transition is really the great opportunity the United States can lead, Senator, as--as we go forward here, is really helping to move through the emissions. As Dr. Birol said so well, it's the emissions. And it's also the water, air, and land impacts. It's the environment that we're talking about, the whole environment. So business, as usual, is--is an interesting term. But nothing is business as usual.

BARRASSO: But then, since you mentioned Dr. Birol, Dr. Birol, let me ask you this. The IEA's 2019 Energy Policy Review for the United States recommends that--it says the United States is poised for further production growth over the coming decade. Facilitating the build out of supporting infrastructure will be a key factor to maximize the benefits of shale both at home and abroad. So on balance, would you agree that the construction of natural gas pipelines, LNG export terminals, here in the United States, is a good thing for the United States, for the world, and for the environment?

BIROL: Yes. The U.S. LNG, especially when it is exported to Asia, as I said a few minutes ago. As of this last two months, the biggest buyer of U.S. LNG is China, by the way, and other Asian countries. When it replaces coal, it reduces the emissions. But once again, it is important that the--the methane emissions in the United States need to be addressed and minimized. Otherwise, soon, there may be some challenges to find the customers as they may look a methane footprint of the U.S. LNG. So--but in general, it can help to reduce the emissions from coal and also have to reduce the air pollution in the cities in Asia.

BARRASSO: But let me ask you, since the IEA was, I understand, created to ensure the security of energy supplies, particularly oil, the United States is now the world's largest producer of crude oil and natural gas. On balance, has the emergence of the United States as the top oil and gas producer increased the stability and security of global energy markets?

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BIROL: Definitely, yes.

BRASSARRO: Thank you. Thank you, Mr. Chairman.

MANCHIN: And with that I will say, I want to thank all the witnesses. Y'all have been wonderful. I appreciate the time you've spent to come here in person. But also, those on the on the web, I appreciate very much that you're sharing with us your expertise. And we're going to be calling on you much, much more during this Congress. With that, members have until the close of business tomorrow to submit additional questions for record. The committee stands adjourned.

Classification

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