

**COLORADO'S ROADMAP FOR CLEAN ENERGY  
ACTION: LESSONS FROM STATE AND  
LOCAL LEADERS**

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**HEARING**  
BEFORE THE  
**SELECT COMMITTEE ON THE  
CLIMATE CRISIS**  
**HOUSE OF REPRESENTATIVES**  
ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

HEARING HELD  
AUGUST 1, 2019

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## **COLORADO'S ROADMAP FOR CLEAN ENERGY ACTION: LESSONS FROM STATE AND LOCAL LEADERS**

**THURSDAY, AUGUST 1, 2019**

HOUSE OF REPRESENTATIVES,  
SELECT COMMITTEE ON THE CLIMATE CRISIS,  
*Washington, DC.*

The committee met, pursuant to call, at 9:10 a.m., at University of Colorado-Boulder, 2450 Kittredge Loop Dr., Wolf Law Building 401 UCB, Wittemyer Courtroom, Boulder, CO, Hon. Kathy Castor presiding.

Present: Representatives Castor, Casten, Neguse, and Graves.

Also present: Representative DeGette.

Chairwoman CASTOR. Welcome, everyone, to the House Select Committee on the Climate Crisis, our first national field hearing. The committee will come to order.

Without objection, the Chair is authorized to declare a recess of the committee at any time.

I am Congresswoman Kathy Castor of Florida. I am honored to be here in the great State of Colorado.

Without objection, Representative Diana DeGette, the gentlewoman from Colorado, shall be permitted to join the committee on the dais and be recognized for questioning of witnesses.

Today we will discuss Colorado's state and local efforts to reduce greenhouse gas emissions and expand the deployment of clean energy and clean vehicles at the Select Committee's first field hearing. So I recognize myself for 5 minutes to give an opening statement.

Thank you all for joining us today for the committee's first field hearing. I am excited to be in the great State of Colorado as the committee works to develop a national climate plan. We need to build on what is working in states and communities across this great country.

It is appropriate that we are here on Colorado Day. It is the 143rd anniversary of Colorado becoming a state.

[Applause.]

Chairwoman CASTOR. Natural resources have always been a critical part of Colorado's economy. Today, in this century of the climate crisis, those resources also include the intellectual and entrepreneurial resources. We have seen some of these in the past couple of days at the National Renewable Energy Lab, NCAR, NOAA, and with scientists and students here at UC-Boulder. They are doing the cutting-edge research on the climate crisis and the solu-

tions to tackle the crisis. We are also honored that our recent House of Representatives colleague, now Governor Polis, is spending part of his first Colorado Day as governor with us.

When we say the states are the laboratories of democracy, we mean that literally here. Colorado is home to some of the leading research in climate change and clean energy. And one of the most important things we can do as policymakers is make sure that clean technology can move from the lab to the market. That is what creates jobs, that is what cuts pollution, and that is what makes America the leader in clean energy. We need to build the clean energy economy to solve the climate crisis.

Colorado in particular has been a leader in the clean energy revolution. In the 2019 legislative session, the Governor and the Colorado legislature have added to Colorado's clean energy legacy by enacting several bills focused on deploying more energy efficiency, renewable energy, and electric vehicles. Equally important, they also created new programs to support the energy workforce, the clean energy workforce. Today we will be learning more about those policies and their benefits from a variety of perspectives to inform the Select Committee's work.

The climate crisis is the challenge of our lifetime. When we confront it, it makes us realize that we are all in this together and that it will take creativity, innovation, and persistence by everyone to solve it. Those same qualities are what helped America land the first person on the moon. Recently, we celebrated the 50th anniversary of the Apollo 11 mission. Those first steps on the moon proved that America can do anything when we work together. I have always found an extra measure of inspiration in Apollo because I am from Florida, and because when I first came to Congress I had the honor of inheriting John F. Kennedy's office in the Cannon House Office Building.

A lot of people don't know this, but JFK was also the first president to receive a warning about how humans were changing our climate. Every president since then has received starker and starker warnings from the scientific community about the consequences of carbon pollution and climate change.

Landing a man on the moon and returning him safely to Earth was a grand challenge. Making Earth's atmosphere safe for everyone is now a grander one for all of us.

We don't have time to waste. We need to act as swiftly as possible. Our next moonshot is solving the climate crisis. I know we can do it. And I know Colorado is going to help us lead the way.

[The statement of Ms. Castor follows:]

**Opening Statement (As Prepared for Delivery)**

**Rep. Kathy Castor (D-FL), Chair**

**U.S. House Select Committee on the Climate Crisis**

**Colorado's Roadmap for Clean Energy Action: Lessons from State and Local Leaders**

**August 1, 2019**

Good morning and thank you for joining us for our first field hearing. I'm excited to be in the great State of Colorado because as this committee works on a national climate plan, we need to build on what's working in our states.

We are here on Colorado Day—the 143rd anniversary of Colorado becoming a state. Natural resources have always been a critical part of Colorado’s economy. In the 21st century, those also include the intellectual and entrepreneurial resources we have seen in the past few days visiting national and state scientists, who are doing cutting edge research on the climate crisis and solutions for it. We are also honored that our recent House of Representatives colleague, now Governor Polis, is spending part of his first Colorado Day as governor with us.

When we say the states are laboratories of democracy, we mean that literally here. Colorado is home to some of the leading research in climate change and clean energy. And one of the most important things we can do as policymakers is make sure clean technology can move from the lab to the market—that’s what creates jobs, that’s what cuts pollution, that’s what makes America a leader in the clean energy economy we have to build to solve the climate crisis.

Colorado in particular has been a leader in the clean energy revolution. In the 2019 legislative session, the governor and Colorado legislature have added to Colorado’s clean energy legacy by enacting several bills focused on deploying more energy efficiency, renewable energy and electric vehicles. Equally important, they also created new programs to support the energy workforce. Today we will be learning more about those policies and their benefits from a variety of perspectives to inform the Select Committee’s work.

The climate crisis is a huge problem. When we confront it, it makes us realize that we’re all in this together. And that it will take creativity, innovation and persistence by everyone to solve it.

Those same qualities are what helped America land the first men on the moon. Recently, we celebrated the 50th anniversary of the Apollo 11 mission. Those first steps on the moon proved that America can do anything when we work together. I’ve always found an extra measure of inspiration in Apollo because I’m from Florida, and because when I first came to Congress, I had to honor of inheriting John F. Kennedy’s former office.

A lot of people don’t know this, but JFK was also the first president to receive a warning about how humans were changing our climate. Every president since then has received starker and starker warnings from the scientific community about the consequences of carbon pollution and climate change.

Landing a man on the moon and returning him safely to Earth was a grand challenge. Making Earth’s atmosphere safe for everyone is an even grander one.

The Apollo program was a national effort that mobilized our scientific and engineering capabilities in the federal government, academic institutions and private industry. The climate crisis requires that same commitment and more. As we will hear today the solutions have already started with our state and local governments. We need to act as swiftly as possible to follow your lead.

Our next moonshot is solving the climate crisis. I know we can do it. And I know Colorado is going to help us lead the way.

Now I am going to yield the balance of my time to another inspiration for all of us, the great representative of this community, Congressman Joe Neguse.

Good morning, Joe.

[Applause.]

Mr. NEGUSE. Well, I first want to say thank you to Madam Chairwoman Castor for selecting Boulder as the location for the very first field hearing of the Select Committee on the Climate Crisis. And welcome to Boulder to my colleagues. It is such an honor to be able to join the committee in visiting my home state, my home district, my home town, and my alma mater, CU and CU Law School.

So I want to thank everyone here today, the witnesses who will be testifying, the many activists and local leaders who have helped in so many different ways in the fight against the existential threat of climate change.

I in particular want to recognize my fellow committee members, Representative Casten from the great State of Illinois; the Ranking Member, Representative Graves from Louisiana; Representative Buddy Carter from Georgia, who unfortunately had to leave last

night but joined us for much of the trip; and, of course, the dean of our delegation, Representative DeGette. Thank you all for being willing to spend your time here in Boulder.

I can think of no better place than Boulder, Colorado, and Colorado as a state, to host the first field hearing of the Select Committee on the Climate Crisis. It is the epicenter of climate research in the United States. It has been an honor to be able to visit with a number of scientists over the course of the last two days at NREL and at NOAA and at UCAR and NCAR and CIRES and so many other of the wonderful Federal research laboratories that we have here in our state that we are so lucky and blessed to be able to call home.

So I look forward to today's proceedings. This climate emergency requires us to take comprehensive and bold action, in my view, and, I believe, in the view of the members of this committee, and I am so grateful for the Chairwoman's leadership on that front.

With that, I would yield back.

Chairwoman CASTOR. Thank you, Congressman Neguse.

At this time, I will recognize our Ranking Member, Garret Graves of Louisiana, for an opening statement.

Mr. GRAVES. Thank you, Madam Chair.

I want to thank all of you for being here to participate in your government. This is what the United States looks like, and I really do appreciate every single one of you being here to share your thoughts, to participate, and to ensure that you are being represented.

Governor, I want to thank you for being here. I had the chance to serve on the House Natural Resources Committee with your governor, certainly a very well-equipped, bright guy. And I have to tell you, I miss you, I miss working with you on the committee. We had a number of amendments that we were able to work on together. But congratulations to you, and I have no doubt that you are going to do great things here, so thank you for being with us.

Congressman Neguse, I want to thank you as well. The short trip—I arrived just yesterday morning. This place has been amazing, it really has. The people have been amazing.

Mayor, I want to thank you very much for being here and for welcoming us as well.

Climate change. I represent south Louisiana. We have to get this right, but we have to get this right. I want to explain what I mean there.

First of all, we are in Boulder, Colorado. So we can sit here and we can talk about the symptoms of climate change and what is going to happen here and what has happened here. Let me tell you about where I live.

We have lost 2,000 square miles of our state, 2,000. How big is that? If it were the State of Rhode Island, we would have 49 states today, alright? This isn't some place where birds and fish live. This is people. This is homes. This is businesses. This is history.

Our tourism department years ago—we have this area called the Atchafalaya Basin. It is one of the only open river floodplains undisturbed in the nation, and it is just teeming with wildlife. It is amazing. Bears and alligators and deer, just a really amazing place. But they kicked off this tourism campaign, and they said the

Atchafalaya Basin, America's foreign country. And I was like, oh, that is awesome. And it is, it is awesome.

But you know what? That is south Louisiana, the place, the people that I represent, the culture, the music, the food, the people. There is nowhere else. And to watch that disappear, literally—we lose a football field of land approximately every hour, a football field every hour.

So sea rise is one of the contributing factors. There are a few others. It is one of the contributing factors for our loss. You can look and you have seen the International Panel on Climate Change, the IPCC. You looked at their projections of sea rise. We don't have the Flatirons. If we have a slope in Louisiana, it goes from here to there. So when sea rises, it inundates. It inundates our homes, it inundates our businesses, it inundates our history, it inundates our ecosystem.

Actually, I worked on an amendment in one of our committees—I think Joe was about to throw something at me—where I tried to get Cajuns deemed an endangered species. [Laughter.]

It didn't work.

So from home, from the people I represent, we have to get this right.

Now, let me explain the other reason we have to get this right. We have had people, experts, come before our committee who have said we can cut every bit of emissions, every single bit of emissions from the United States today, everything, and it is not going to change the trajectory of warming.

This place, Boulder, is amazing. Yesterday I had the opportunity to go to the National Renewable Energy Lab. I had the opportunity to go to the University Corporation for Atmospheric Research. I have been to CIRES before. I have been to the Earth System Research Laboratory before. This place is going to be absolutely key in solving the problem, and what I mean by that is the experts, the facilities, the scientists that you have here, the innovation, the moon shot that the Chair just talked about.

But when you look at what some places have done, up in the northeast, some of the efforts to go very, very aggressive, they have actually caused energy prices to triple those compared to my home state. In my home state, we can't afford it. We have a high rate of poverty. We can't afford a tripling of energy. They have actually carried out policies that have required the importation of natural gas from Russia. They have caused folks to burn wood in stoves in their homes. They have caused the burning of heating oil.

In California, we have increased our dependence upon oil from Saudi Arabia. Let me say that again: We have increased our dependence upon oil from Saudi Arabia.

Here is a little-known fact. In the United States today we have reduced emissions greater than the next 12 countries combined, the United States has twelve countries combined. So we can continue down this path of making this an incredibly polarizing issue and make it this big partisan fight, or we can recognize that we are all in this together, not just in Boulder, not just in Colorado, not just in the United States, but the globe, because as the United States has been the world leader in reduced carbon emissions greenhouse gas emissions by a billion tons, China during that same period of

time has increased by 4 billion tons, more than offsetting every bit of progress we have made here in the States.

Let me say it again. This place, Boulder, Colorado, the scientists, the experts, the facilities you have here, this place is going to lead the innovation not just for Boulder, not just for Colorado, not just for the United States, but for the world. And we are going to have to keep working together and stop this ridiculousness about all the partisan fighting that we are seeing on this issue and virtually everything else, because we are all in this together.

It doesn't matter if you are Republican, Democrat, green, purple, blue, white, whatever. When your land is being taken, when your home is going underwater, when your business is going underwater, when your history, your culture is going underwater, it doesn't matter. It doesn't matter what label. It affects every single one of us.

So let me say it again, Madam Chairwoman. I want to thank you for choosing Boulder, Colorado. Joe, Congresswoman DeGette, I want to thank you very much for hosting this today. Congressman Casten, thanks for coming. And most importantly, I want to thank you all for being here to participate in your government, and we have got to work together to figure out a solution that gets it right and gets it right.

I yield back.

[Applause.]

Chairwoman CASTOR. Thank you. Thank you, Mr. Graves.

Now we will move on to our witnesses.

We have two panels today. The first panel is the Honorable Jared Polis, and I yield to Congressman Neguse to introduce the Governor.

Mr. NEGUSE. Thank you, Madam Chair. I am proud today to introduce the Governor of Colorado, Jared Polis.

Before being elected governor, Jared Polis served as a board member and Chair of the Colorado State Board of Education. He was then elected to represent Colorado's 2nd Congressional District, which I am honored to serve today.

The 2nd District stretches from Larimer County and the Wyoming border to the central mountains at the heart of Colorado's tourism economy, to Boulder and the U.S. 36 high-tech corridor.

In his time in the United States House of Representatives, then-Congressman Polis was a strong advocate for finding solutions to environmental issues. He was a national leader for protecting our treasured public lands and addressing climate change.

After 10 years of honorable service in the United States House of Representatives, he successfully ran for governor last year, in 2018, on the platform of full-day kindergarten for all, reducing health care costs, and transitioning to 100 percent renewable energy by 2040.

As the Governor of Colorado, Jared Polis has made significant progress towards these goals during his first seven months in office, and he has left incredibly large shoes for me to fill as the congressman for this congressional district.

I am thrilled to welcome him to the Select Committee's first field hearing to share his testimony and his experience. Please welcome our Governor of Colorado, Jared Polis.

[Applause.]

Chairwoman CASTOR. And without objection, the witness' 5-minute testimony will be entered into the record.

At this time, Governor, you are recognized to give a 5-minute presentation.

**STATEMENT OF THE HONORABLE JARED POLIS, GOVERNOR  
OF COLORADO**

**STATEMENT OF JARED POLIS**

Governor POLIS. Good morning, Madam Chair, Ranking Member Graves, Representative Neguse, Representative Casten, Representative DeGette. I had the pleasure of serving with many of you for a number of years. And today, on Colorado's 143rd birthday, which Madam Chair so kindly recognized, I am honored to welcome you to Colorado for a very important field hearing to discuss climate change, an existential threat to our security, our health, our economy, our public lands and ecosystems, and our very way of life.

Colorado's climate has warmed substantially over the past 30 years, and even more than that over the last half century. Time is quickly running out to take bold action to reverse and alter the current trajectory.

In Colorado, we know this hotter, more erratic, drier future isn't some dystopian vision. It is impacting us right now. It is impacting our dwindling water supply, impacting our farming and ranching communities, our outdoor recreation industry, our wildlife and ecological diversity. It is causing more frequent, more devastating, and more expensive national disasters, which also costs the Federal government money.

If we want to preserve our way of life for future generations, we need to take bold action to address the climate crisis.

We have more than just a moral imperative to combat climate change. In Colorado, as an example, and, of course, across America, we also have an economic imperative to lead the global green energy revolution, to make the future work for us.

We have a choice. We can be a leader in renewable energy, or we can let other countries develop the technologies, create the jobs, and reap the rewards of the renewable energy future.

In Colorado, as you have seen over the last couple of days, we chose to lead. I ran on a platform of achieving 100 percent renewable energy across our great state by 2040 because I know that that will preserve our way of life and grow our economy well into the future. This commitment was inspired and informed by the 14 towns and counties across our state that have also adopted the call of getting to 100 percent of their electricity from renewable energy by 2040, or in many cases even sooner.

That is why my administration released our Roadmap to 100 Percent Renewable Energy and Bold Climate Action. You have a copy of that in front of you as an exhibit. This Roadmap outlines how we will drive innovation and build Colorado's economy by continuing and growing our leadership in green energy development.

We have taken significant strides during my first seven months in office to put us on the path to achieving this bold goal. But the truth is that through price reductions and technological advances,

the shift towards renewable energy is already happening, and that is good news.

The Bureau of Labor Statistics reports that the two fastest growing jobs in the United States right now are wind turbine technicians and solar panel installers. In Colorado, our largest utility, Xcel Energy, announced last fall that they would retire 660 megawatts of coal a decade early and replace it with more than 1,800 megawatts of wind, solar, and battery storage. In doing so, they estimate over \$200 million in savings for customers with no impact on reliability.

This effort is just a piece of Xcel's broader commitment to reduce emissions 80 percent by 2030 and produce 100 percent carbon-free electricity by 2050, a commitment that our state legislature, working with us, codified in statute this past spring.

Other electric providers across Colorado—Holy Cross Energy, Platte River Power Authority, and a number of other rural electric cooperatives—have also followed suit, and Colorado is proud to have the very first municipal utility in the entire nation to have already achieved 100 percent renewable energy, the Aspen municipal utility.

It is undeniable that companies see a profitable future in renewables, and given the dire stakes, it is our job as policymakers to accelerate the transition towards a cleaner, greener, more sustainable, and more affordable energy future.

Let's take transportation, the nation's largest source of greenhouse gas emissions. My very first executive order set into motion the establishment of a Zero Emission Vehicle Center, an investment in electric charging infrastructure, to make it easier for consumers to choose electric vehicles.

We also, for the grid, unlocked financing solutions, including securitization, to help reduce the cost of retiring coal-fired plants. We also passed Senate Bill 181 to put health and safety first and give local residents a say in what happens in their communities when it comes to oil and gas drilling operations, in addition to setting up a process to minimize fugitive emissions of methane and other pollutants from oil and gas activities.

We don't have to choose between creating good jobs and saving our air, our water, and our way of life. We can and we must do both by growing our renewable energy sector.

When it comes to renewable energy and climate action, I believe that Colorado has a lot to show the rest of the nation, and I have no doubt that we can take bold action at the Federal level as well. I was glad to see the House pass H.R. 9 to keep America in the Paris Climate Agreement, and I hope the Senate follows suit.

The United States does not back down from a challenge. We are a nation of leaders, of doers, of dreamers. In America, we get to choose our own destiny. Thank you for allowing me to testify this morning, and I look forward to answering your questions.

[The statement of Governor Polis follows:]

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**Written Testimony of Governor Jared Polis  
Governor of Colorado**

**House Select Committee on the Climate Crisis  
“Colorado’s Roadmap for Clean Energy Action: Lessons from State and  
Local Leaders”**

**August 1, 2019**

Good morning, Chairwoman Castor, Ranking Member Graves, and the members of the House Select Committee. Thank you for the opportunity to testify in front of you all today here in the great State of Colorado for your committee’s first field hearing.

My name is Jared Polis and I serve as the 43rd governor of the State of Colorado, and as such I welcome you to our great state for this important Congressional field hearing. I was born and currently live here in Boulder, and before serving as Governor, I represented Boulder, Fort Collins and the rest of Colorado’s 2nd District in the House of Representatives for a decade. I am proud to see our Colorado Representatives Neguse and DeGette here today protecting Coloradans by leading our nation’s efforts to combat the climate crisis on the Select Committee.

Today, I will provide an overview of Colorado’s urgent efforts to-date to achieve 100% renewable energy and bold climate action. It is my hope that other states and the federal government can draw lessons from Colorado to achieve substantial and permanent reductions in pollution and other activities that contribute to the climate crisis.

COLORADANS LEADING ON CLIMATE ACTION

Since 2004, Colorado has been among the states leading the clean energy transition. Not only do we have a moral imperative to combat climate change to protect the health of our communities and our environment, we also have an economic opportunity to lead the global clean energy revolution.

We have a choice: we can be a leader in renewable energy, or we can let other countries develop technologies, create the jobs, and reap the rewards of a renewable energy future. In Colorado, we have chosen to lead.

*Renewable Energy Standard:* In 2004, Coloradans approved Amendment 37, which established the first voter-approved state renewable energy standard, originally set at 10% by 2020 for our investor owned utilities. Subsequent legislation increased this to 30%.

*Clean Energy Utilities:* Since 2004, the State’s largest electric utility, Xcel Energy, has increased its renewable energy from zero to roughly 3,600 megawatts of wind and solar installed today. Part of this clean energy is supplied by almost 50,000 Coloradans that have solar installed on their rooftops. HB10-1365—the Clean Air Clean Jobs Act—established a process to bring the state into compliance with federal Clean Air Act requirements by retiring, retrofitting, or repowering 900 megawatts of coal-based power generation from Xcel’s Colorado system. After recent state Public Utilities Commission (PUC) approval of the Colorado Energy Plan, Xcel plans to retire two more coal units a decade early and projects that by 2026, nearly 55% of the electricity it provides to customers will be from renewable resources. The Colorado Energy Plan was not driven by a legislative mandate, but rather by the remarkable reductions we have seen in the cost of wind and solar. Recent bids for new utility scale renewables have come in at about two cents per kwh for wind combined with battery storage and about 3 cents for solar—while simply operating existing legacy coal plants is over 4 cents per kwh. A study released earlier this year by Vibrant Clean Energy concluded that Colorado could close every coal plant in the state, replace them primarily with new wind and solar, and dramatically reduce greenhouse gas emissions from electricity generation—all while saving ratepayers more than \$2.5 BILLION and having a net increase in jobs.

Utilities across the state are committing to an ambitious transition towards renewable energy because they know this is where the industry is headed—in Colorado and across the nation—and, they want to thrive as part of the 21st century, clean energy economy. We share that vision for the state. Xcel Energy has committed to an 80% reduction in emissions below 2005 levels by 2030 and is striving to reach 100% by 2050. We worked with Xcel and the legislature this spring to codify the goal of an 80% reduction by 2030 and create a pathway for approval of a plan by the state PUC. As part of the same bill, SB19-236, Colorado now requires the use of a social cost of carbon in utility planning to make sure that we are considering the very real costs imposed by carbon pollution. This is an analytical frame-

work that will allow us to more precisely consider all costs and better inform our decision-making when deciding on generating resources, as well as investments in energy efficiency, electric vehicle (EV) infrastructure, or beneficial electrification. SB 236 also, for the first time, brings our largest rural utility, Tri-State Generation and Transmission, into PUC jurisdiction of their electric resource planning. Tri-State recently announced intentions to develop a Responsible Energy Plan, designed to establish pathways to comply with the state's carbon reduction and renewable energy goals. We look forward to engaging with Tri-State in their planning processes and at the PUC to continue to progress to an affordable and reliable clean energy future. Other utilities across the state are also showing leadership. Holy Cross Energy, the electric utility for several mountain communities in central Colorado, recently adopted a goal of 70% renewable energy by 2030 and now expects to achieve that goal 9 years ahead of schedule. Platte River Power Authority in Northern Colorado has also recently adopted an energy policy calling for a 100% zero carbon energy mix by 2030.

*Clean Energy Local Action:* Fourteen Colorado towns and counties have already taken the initiative and adopted the goal of getting 100% of their electricity from clean renewable energy: Denver, Pueblo, Boulder, Fort Collins, Summit County, Frisco, Aspen, Glenwood Springs, Breckenridge, Longmont, Lafayette, Nederland to Golden. These diverse communities know that protecting Colorado's way of life means doing our part to combat climate change, and that swiftly adopting renewable energy in our electricity sector and then extending the impact of that clean electricity across the economy will protect the health of our communities, create good-paying jobs, strengthen our economy, and keep rates low for customers. Our rural electric co-ops are also taking bold steps. In June 2019, Poudre Valley Rural Electric Association announced a new goal to provide 80% carbon-free energy to its members by 2030, joining three other electric coops in Colorado to establish a clean energy or carbon reduction goal. Delta Montrose Electric Association also recently announced an agreement to exit Tri-State in order to pursue higher levels of local, renewable energy generation.

*Clean Transportation:* Colorado is also taking the lead on moving towards clean transportation. While electricity generation is our largest single source of emissions, transportation is a close second. And while electricity generation is already on a path towards deep emissions reductions, transportation is not. Added to this, cars and trucks are one of the two largest sources of ozone precursors, which contribute to smog on our front range. That is why Colorado has stepped up to support cleaner vehicles and transportation systems. But we need the federal government to step up too. The biggest single step that the federal government has taken on climate was adoption of federal clean car standards that will cut emissions per mile in half by 2025, while saving consumers hundreds of billions of dollars in fuel costs. In 2017, a national consulting firm studied Colorado and concluded that a large-scale transition to EVs by 2050 would create a net savings of \$43 billion for Coloradans. Unfortunately, the current administration is trying to roll back these standards, despite near unanimous opposition even from the automobile industry.

Last year, Colorado adopted Low Emission Vehicle standards, which will reduce emissions by over 2 million tons a year of carbon pollution compared to the proposed rollback—while saving our consumers hundreds of millions of dollars. We are also in the midst of considering adoption of zero emission vehicle (ZEV) standards, which will require automakers to make more EVs available to Colorado consumers.

And, I am proud to announce that earlier this week, state agencies announced an agreement with the Alliance of Automobile Manufacturers and the Global Automobile Alliance, which together represent over 99% of the vehicle market in Colorado, to support a ZEV standard that works for the state and for the industry. The proposal will not only increase ZEV adoption and provide air quality benefits, but also will drive early ZEV adoption and ensure the automakers can implement the regulation efficiently. We are hopeful that this signifies a new era of common-sense cooperation between states and the automobile industry, working together to reduce emissions.

This progress builds on the fact that Colorado already has the fourth highest EV market share in the nation. Some people may think of EVs as something we only see in coastal states or heavily urbanized states, but, in fact, the mountain west has emerged as an EV hotspot. Colorado, Utah, Nevada, and Arizona have consistently been in the top ten states for EV market share, and I am proud that the governors of every mountain west state—Arizona, New Mexico, Utah, Nevada, Wyoming, Idaho, Montana and Colorado—have joined together in an eight state Regional Electric Vehicle West Memorandum of Understanding, collectively committing to build fast charging along every interstate highway connecting our states. Colorado signed a contract with the company ChargePoint in April of this year, and by June 30,

2020, we should have 33 fast charging stations along major highway corridors. When combined with fast-charging stations planned by Electrify America, the program will provide fast-charging every 30–50 miles along Colorado’s major transportation corridors.

Colorado currently has the highest ZEV incentive of any state in the country (\$5,000 per ZEV tax credit), which the legislature recently extended through 2025. Financial incentives are important to increasing ZEV sales and are a factor in Colorado having higher sales than all but three other states.

Colorado is also building out a direct current fast charger network through the state’s major corridors to address “range anxiety” allowing the use of EVs for longer trips.

While Colorado is already developing robust electric charging infrastructure, we passed legislation this year that requires electric utilities to file transportation electrification plans with the PUC every three years starting in 2020 to further expand that infrastructure.

The State is spending the maximum allowable amount of the Volkswagen Settlement funds on light-duty EV charging infrastructure (15% or \$10.3 million), and an Executive Order I signed in January, directs State agencies to allocate all remaining Volkswagen Settlement funds to support vehicle electrification, including electric buses and school buses. In the executive order, I established a target of nearly a million EVs on the road in Colorado by 2030.

Just as with electricity generation, technological advances in the transportation sector are making it possible for us to reduce emissions while saving money. Even with today’s electric grid in Colorado, powered by nearly 25% renewable energy, it’s far more efficient to drive electric vehicles powered by more efficient utility-scale power production than a distributed, small scale internal combustion engine. Our analysis shows that widespread electrification of our transportation system will save consumers money because of lower fuel costs, will drive down the cost of electricity because it makes the grid function more efficiently, and do all this while cleaning our air and achieving deep reductions in climate pollution.

*Move Towards Zero Emissions Buildings:* While our electricity and transportation sectors are the top two sources of climate warming pollution, fuel use in buildings in our residential, commercial, and industrial sectors is not far behind and is an area where we need to make substantive progress. Achieving the state’s emission reduction goals will require significant reductions in emissions in this sector. Integrating more energy efficiency with the expanded use of clean electricity as an alternative to burning fossil fuels in buildings could bring consumer cost savings, enhanced electric grid operations, and reduced emissions. This past spring, we passed HB19–1260, which requires that local jurisdictions adopt one of the three most recent versions of the International Energy Conservation Code, at a minimum, when updating any other building code. We are also working with local stakeholders to develop next generation building codes that address energy efficiency, building electrification, distributed renewables, and EV charging.

*Reducing Emissions from Oil and Gas Development:* As we work to reduce the use of fossil fuels in our electricity, transportation and building sectors, we must also mitigate methane emissions from oil and gas extraction and the natural gas fuel cycle. In 2014, Colorado became the first state in the nation to enact regulations requiring oil and gas companies to detect and reduce methane emissions. Looking forward, as part of the passage of SB19–181 (historic oil and gas reform legislation that protects public safety, health, welfare, and the environment and reinforces local government’s regulatory authority over the surface impacts of oil and gas development), the Air Quality Control Commission will soon be adopting additional rules to further minimize emission of methane and other pollutants from the oil and gas production process.

*Other Emissions Sources:* As we look to the required emission reductions demanded by the latest available climate science, there is no single sector our strategy that will allow us to achieve our goals. In addition to the numerous progress and activity that I have already outlined, we must continue to convene diverse stakeholders to advance economic and environmental progress in other sectors, such as agriculture, waste management, and our industrial sector.

#### 2019: A YEAR OF ACTION

The 2019 Legislative Session brimmed with incredible clean energy achievements and was arguably the most productive session in the history of this state on clean energy and climate action. We have adopted strong economy-wide targets, outlined in HB19–1261, for reducing greenhouse gas pollution, with goals of 50% reduction below 2005 levels by 2030 and 90% by 2050, which will lead to coordinated action

by the Air Quality Control Commission and other state agencies to implement measures to progress towards those goals.

We have empowered the PUC to facilitate a rapid transition to renewable energy across the state that includes working with our largest utility to invest in renewable energy and reduce greenhouse gas pollution 80% by 2030. We're building a regulatory framework that will enable the PUC to work with our second-largest utility to transition from coal-fired power to cheaper, cleaner sources of energy.

We are making it easier for individual Coloradans to participate in this work by expanding access to energy efficiency and community solar gardens. And, as we continue our work to clean up our electricity sector, Senate Bills 77 and 239 and House Bill 1159 will further support the electrification of our transportation sector.

As I previously mentioned, we have put public safety, health, welfare, and the environment first in the oil and gas sector, and empowered local governments to make decisions about oil and gas operations. We are starting rulemaking to implement the direction of Senate Bill 181 to minimize methane and other emissions from oil and gas development.

We have unlocked creative financing solutions to help reduce the cost of retiring coal-fired power plants and we will establish a Just Transition Office tasked with aligning and delivering programming and funding to communities and workers impacted by a transition away from coal-fired electricity, in addition to disproportionately impacted communities who have borne the costs of pollution.

In addition, through Senate Bill 96, my administration and the legislature took steps to ensure a more consistent and robust tracking and reporting of Colorado's greenhouse gas emissions, which is foundational to effectively implementing a wide range of policies and programs designed to allow the state to cost-effectively meet its emission reduction goals.

We have worked together combining shared values with incredibly diverse strengths to prioritize the future of our great state. We have proved that we can take bold, decisive action on climate and clean energy. This legislative session has put Colorado on the right path.

#### COLORADANS DELIVERING RESULTS

My Administration is inheriting and building upon many years of Colorado's clean energy leadership working to reduce greenhouse gas pollution, improve air quality, and save money for Coloradans.

Shifting to clean energy has been an economic engine in Colorado. According to one analysis,<sup>1</sup> Colorado has roughly 57,000 clean energy jobs including 34,342 Energy Efficiency jobs, 7,819 solar jobs, 7,320 wind jobs, and 2,713 clean vehicle jobs.

In 2004, Colorado's electricity generation mix was 75% coal and roughly 25% natural gas. In 2017, the most recent year for which we have data, Colorado has 54% coal, 22% natural gas, and 20% renewable energy. That is a 20% increase in renewable energy and a 21% reduction in coal energy generation. During the same period, from 2004 to 2017, Colorado has seen a 13% decline in carbon emissions from electricity generation in the state.

In 1990, electricity generation accounted for 43% of Colorado's greenhouse gas emissions. By 2015, the last year for which there is available data, electricity accounted for just 34% of the state's greenhouse gas emissions.

In July, the Colorado Department of Public Health & Environment released the draft Greenhouse Gas Inventory 2019 Update.<sup>2</sup> Colorado greenhouse gas emissions increased between 1990 and 2010 and decreased between 2010 and 2015. While we need to make much more progress to achieve our goals, we should also celebrate that this is the first time that the inventory shows a decline in emissions. Emissions are projected to continue decreasing, dropping below 2005 levels by 2030. Figure 1 shows a graphical summary of estimated Colorado greenhouse gas emissions by sector, including projections to 2020 and 2030.

<sup>1</sup>U.S. Energy and Employment Report 2019. Colorado. Last accessed on 7/29/19. <https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5c7f4096e79c70c65fe31745/1551843478412/Colorado.pdf>.

<sup>2</sup>Colorado Department of Public Health & Environment. DRAFT Colorado Greenhouse Gas Inventory 2019. Last accessed on 7/29/19. <https://drive.google.com/file/d/1120LdxmexGTuf7uil9l6YmjOQonYOnxV/view>.

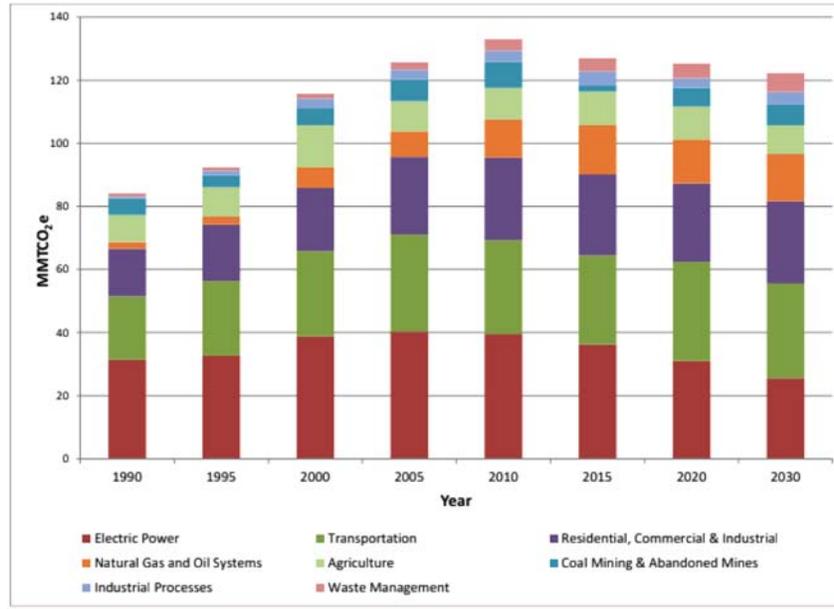


Figure 1: Estimated Greenhouse Gas Emissions by Sector

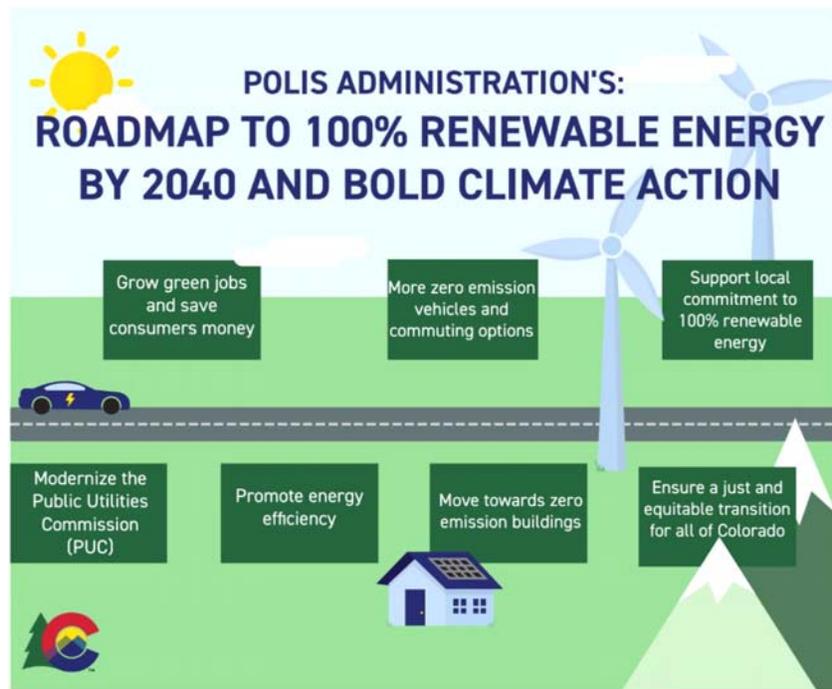
ROADMAP TO 100% RENEWABLE ENERGY AND BOLD CLIMATE ACTION

My administration is committed to pushing Colorado forward on the path to achieving 100% Renewable Energy by 2040. In June, when I signed seven climate and energy bills at a community solar garden, I released my administration's Roadmap to 100% Renewable Energy by 2040 and Bold Climate Action.<sup>3</sup> This pledge is motivated by the moral imperative to fight climate change and curb pollution of our air and water and, as a governor of the great State of Colorado, to protect and preserve what is special to us here in the West.

The clean energy transition is also an opportunity to drive innovation and build Colorado's economy by continuing our leadership role in the green-energy economy. This transition is not just about jobs—the transition to cleaner electricity and transportation will help businesses and homeowners save money by switching to lower-cost, clean energy resources.

The policies adopted in this legislative session provide the foundation for much higher levels of renewable energy integration, but additional strategies will be needed to get to 100% by 2040. Given the shift that is already underway in Colorado's electricity sector, it has never been more important than now to focus on reducing greenhouse gas emissions from other sectors in the state. It is going to take the perspective, expertise, and commitment from diverse voices across the state to forge a renewable energy future that works for all of Colorado.

<sup>3</sup>Office of the Governor of Colorado. Roadmap to 100% Renewable Energy by 2040 and Bold Climate Action. Last accessed on 7/29/19. <https://drive.google.com/file/d/0B7w3bkFgg92dMkpxY3VsNk5nVGZGOHJGRUV5VnJwQ1U4VWtF/view>.



*Figure 2: Roadmap to 100% Renewable Energy by 2040 and Bold Climate Action*

Together, we can do our part to fight climate change, improve air quality and the health of our communities, diversify and strengthen our economy across the state, and ensure the good-paying jobs of the quickly growing green energy economy are created here in Colorado.

#### COLORADO—A MODEL FOR THE NATION

When it comes to clean energy action, I believe Colorado is a model for the nation. I have no doubt we can take bold action at the federal level as well.

I was glad to see the House pass H.R. Bill 9 to keep America in the Paris Climate Agreement, and I urge the Senate to take it up. There is no economic or moral reason for the United States—the most powerful economy in the world—to stick our heads in the sand while 185 other countries lead the way on combating climate change and developing renewable energy.

The United States is not a nation that backs down from a challenge. We are a nation of leaders, of doers, of dreamers. In America, we get to choose our own destiny.

Thank you again for allowing me to testify this morning. I look forward to answering your questions.

[Applause.]

Chairwoman CASTOR. Thank you, Governor, for your impressive testimony and your bold action since you have taken office.

At this time, I will recognize myself for 5 minutes to begin the questions.

So, to prepare for this trip, I took a look at the state of Colorado's energy mix over the past decades, and what struck me is how quickly renewable energy from various sources have replaced coal, really just in the past 7 to 10 years. It has been a remarkable switch. You are not where you need to be, however.

What lessons can we draw as we develop bold climate action plans and policies at the national level? What are the lessons that you think we should write into that national climate action plan? What has worked here? What was the impetus? Give us a little guidance on where we should go nationally.

Governor POLIS. The voters in our state showed a leadership role by passing a state renewable portfolio standard, and Colorado has exceeded that in recent years. We are at about 25 percent renewable energy for the grid. We have a different mix of utilities, municipal providers and co-ops, and in some areas of the state it is even higher, and we know that we can do even more.

At the same time that we have grown our renewable energy, we also have in the Xcel service area some of the lowest electricity rates in the nation for consumers and businesses. We have also incorporated friendly policies to support distributed solar energy, including making sure that the feed-in rate is fair for people, and have allowed innovative financing mechanisms and leveraged Federal financing mechanisms like the PACE financing mechanism, which, if expanded to residential in an easier way, would further facilitate distributed solar.

So we look forward to continuing to work with the Federal Government, as well as our mixture of utilities, to help get them to the next level of renewable energy.

Chairwoman CASTOR. I listened very closely to the Ranking Member, and he is very intelligent on these issues. But one place where I tend to disagree with him and that your testimony raised is, as we transition to clean energy, it doesn't necessarily mean higher energy costs for our neighbors and for businesses. Would you expound on that point? Because in your testimony you said it has actually helped to lower electricity costs.

Governor POLIS. Yes, renewable energy is less expensive today. So coal-powered plants often produce energy at 20 or 30 percent higher costs than renewable energy. It is really a question of how we can distribute those sunk costs that exist in the capitalization of coal into saving money with renewable energy. Technologies are improving, prices are going down. In the long run we don't only save money but we are also saving money that would have been used to recover from climate-related natural disasters and health issues caused by both poor air quality as well as climate change.

So it has really been a matter of working with the various forms of utilities we have to accelerate the retirement of costly coal assets, to recognize savings for consumers sooner, and environmental benefits sooner.

Chairwoman CASTOR. And government can't do this alone. Give us a few examples of the collaboration between the State of Colorado, local communities, and the private sector.

Governor POLIS. So, many of our local communities have led the way, and you will be hearing from some. But we have 14 cities and counties across our state with even more aggressive goals for 100 percent renewable energy than the state as a whole. I mentioned that we have one municipal utility already at 100 percent. We have a second in Steamboat Springs that has announced their plans to get to 100 percent this year or early next year.

And they found a partner in the state. So it is working with the local communities, the municipal providers, the rural electric coops, and of course through our regulatory authority at the Public Utilities Commission, our investor-owned utilities, to help make sure that this transition benefits customers, benefits workers, and also leads to the quickest possible transition to clean energy.

Chairwoman CASTOR. Thank you, Governor.

At this time I recognize the Ranking Member for 5 minutes for questions.

Mr. GRAVES. Thank you, Madam Chair.

Governor, thanks again for being here. It is great to see you again.

Yesterday we were at the National Renewable Energy Lab, just to give those folks a shout-out again. One of the efforts that they are working on right now is looking at how you position the wind turbines for renewable energy, both the configuration, the pitch and yaw of the blades, and everything else. They have been able to increase the energy generation by 14 percent just by changing the angles. I mean, it is really impressive.

You noted that the energy production costs from some renewables is cost competitive. When you look in a vacuum just at generation, one of the challenges we have is that you are going from these large-scale coal, gas, whatever-fired energy plants to perhaps distributed facilities by having a wind farm over here and having a solar farm over here. The cost of generation is one thing, but we have to fundamentally rethink our electric grid.

How do we do that? I mean, the cost of that potentially is going to dwarf the cost of building some of the renewable energy facilities. How do we address those costs of the grid infrastructure?

Governor POLIS. Well, firstly, I am thrilled that your committee was able to see some of our Federal dollars at work at the National Renewable Energy Laboratory (NREL) and other facilities, as well as university grants across the country. The Federal government is leading the way in cutting-edge research to improve the efficiency of renewable energy generation, as well as storage, which is the second part of the question.

For a reliable grid, as we increasingly incorporate solar and wind energy, the exponential reductions in storage costs have an enormous boom. And often when utilities are pricing out solar and wind, they are adding in that storage component.

So, in fact, in a recent RFP where Xcel priced out wind plus storage, it still came in at about 20 percent less than existing coal power, not to mention new coal power, which would cost even more. Nobody is building new coal. But wind plus storage to ensure reliability of the grid priced out at a better cost.

So those technologies continue to improve. We appreciate the investment not only of NREL but also of sources like ARPA-E, which have invested in storage technology companies, including some here in Colorado, and that is a very appropriate role for the Federal Government, to support the basic research that will help lead this transformation.

Mr. GRAVES. I would love to continue working with you on the infrastructure side of it. I think it is an under-appreciated component. But when you look at electrification of vehicles and other

things, some estimate that (and I know that Colorado has been one of the leaders there) you are looking at a doubling or tripling of the capacity, the demand for electricity. Our existing grid simply can't handle it. It is not designed for this generation network. It is not designed for that volume or capacity of electricity.

One other thing. In your testimony, you note that since 2010 Colorado has doubled the renewable energy production here, and has quadrupled crude oil production here. If you look globally—and we have had witness after witness come before our committees that have talked about how just stopping oil and gas production does not in any way decrease demand, it just means that the production will come from somewhere else. And in talking to experts, things like trucks, rail, ships, the large ships, we don't have the technology today to be able to fuel those through renewable energy sources. The power is too great, so we don't have alternatives.

So what role do you see the United States playing in recognizing that there is continued demand for conventional energy sources? What role do we play in that, recognizing, just like you noted, you all have been one of the leaders in reducing emissions, fugitive emissions from methane and others. As we are going to hear later, natural gas has actually been one of the leading causes of our emission reductions in the United States.

How do we look at this globally and recognize some of the resources here, and use them appropriately?

Governor POLIS. First, on your previous question, I want to be clear. Electric vehicles and our plans to aggressively increase their use are also an important part of load balance and distributed storage. So they have benefits to the grid in terms of having more electric vehicles in use in terms of when and how they charge and/or store electricity in a distributed manner.

Yes, we are leading the way in Colorado with our efforts around Senate Bill 181 to reduce emissions in our extraction industry. It takes additional steps to minimize emissions of methane and other pollutants from the oil and gas production process. In fact, the Federal methane rules were initially modeled after some of the work of my predecessor, John Hickenlooper.

The new efforts that passed this legislative session, in addition to further protecting public safety, health, and welfare in the extraction industry, also reinforced the local government's authority over surface impacts of oil and gas development and helped create a better balance between the existing markets and the need to act on climate change.

Chairwoman CASTOR. Thank you.

Representative Casten, you are recognized for 5 minutes.

Mr. CASTEN. Thank you, Madam Chair.

Thank you, Governor.

I also want to thank CU-Boulder. My parents are both CU buffs. They met and fell in love in their junior year, so I can say with absolute clarity that but for CU-Boulder, I would not be here today. [Laughter.]

[Applause.]

Mr. CASTEN. I want to thank you, Governor, for raising the point about the economics of clean energy, and I want to pick up on a conversation we had briefly last night. Anything you do meaning-

fully to lower the cost of energy and lower CO<sub>2</sub> are synonymous, because you can't lower CO<sub>2</sub> without burning less fuel, and fuel isn't free. And if anybody grapples with that, all you have to do is ask yourself if you have a solar panel on your roof, do you ever wake up in the morning and say, "Boy, the price of electricity is down today, I should probably turn off my solar panel"? But at a coal plant, there is somebody whose job every day, sometimes multiple people whose job it is to say, "What is the forward price of power, and does it make sense for me to run tomorrow?"

We have seen in the last decade a steady reduction in the amount of power from coal because it is not economic, and it is being squeezed out by sources that are much cheaper to run. Now, that is an opportunity. There are some challenges within there, but one of the challenges that I really want to give you a chance to talk about is that in the regulated utility model, the way we electrify our whole country, utilities earn a return on their invested capital. If you retire an asset before you fully return the capital, you bring forward all the unamortized capital expense.

So there are a number of utilities who, in thinking about whether they will retire an uneconomic asset that once it is retired will lower CO<sub>2</sub> emissions, that decision has the impact of increasing electric rates.

You have done something really innovative here to address that problem, and I just would like you to tell us about it, and with the specific idea of if what you have done might be applicable to Federal policy.

Governor POLIS. Yes, and I would encourage you to look at additional Federal policies, including tax policies, that encourage financial innovation, because I think what you hit upon and is very true is that this is largely a matter that through innovative financial mechanisms we can solve. The clean energy is less expensive today. The question is how do you account for the stranded assets in costly coal and other forms of non-renewable energy.

So in Colorado, we move forward with, now under new legislation, allowing for securitization of stranded assets. So effectively we can borrow against the future savings stream to accelerate the retirement of coal assets today, and to help fund a just transition for workers who work in coal-fired plants, and recognize savings for ratepayers sooner rather than later.

Mr. CASTEN. Could we do that federally?

Governor POLIS. There could be Federal policies that facilitate states doing that, and we would be happy to look into what some of those might be and give you some recommendations.

Mr. CASTEN. Thank you.

The second question, and you know this all too well—and I take the point that while Americans have been leaders on a whole host of issues in climate, our Federal government not so much. We have seen cities and states step up to fill the leadership void as the Federal government has backed away. I was involved in setting up the Regional Greenhouse Gas Initiative in New England a decade ago. California, of course, followed with AB-32.

Let's plan for success in this moment. Let's assume that the exceptional leadership on this panel is able to persuade our colleagues in Washington to finally take the kind of bold leadership

that we need at the Federal level, and let's assume that once we do that we push a standard that is even more ambitious than what has been done in the states.

As you have sat on both sides of this question, how should we be thinking about that in a way that expands on ambition but at the same time doesn't frustrate the fact that many people in the states have already made long-term commitments to reduce CO<sub>2</sub> or have binding contracts with renewable portfolio standards? How can we align that with state policy?

Governor POLIS. We hope that your hypothetical becomes reality, and we are celebrating the success of your committee's initiatives sooner rather than later.

Our challenge at the state level is not too different because we have many local jurisdictions within the state. So how do we make sure that we encourage and facilitate communities like Boulder and communities like Aspen and Summit County that have even more aggressive climate goals with local buy-in than the state and then work to make sure that the whole state moves along as well?

It is really a matter of both. Of course, I hope that the Senate acts on House Resolution 9 with regard to rejoining the Paris Climate Accords. I hope that we set bold goals at the Federal level, as well as partner with states and communities who choose to pursue a renewable energy future even faster. So we really have the same issue in many ways at the state level, where we have over 14 communities with aggressive goals. We have a specific initiative to partner with them and help them achieve their goals for their area of jurisdiction, as well as making sure we bring along the rest of the state.

Mr. CASTEN. Thank you.

I yield back.

Chairwoman CASTOR. Congressman Neguse, you are recognized for 5 minutes.

Mr. NEGUSE. Thank you, Madam Chair.

Thank you again, Governor, for being here today, for spending so much time with us, and for your testimony and your leadership.

I also appreciate you recognizing the local leadership. One of the reasons that I advocated for the Select Committee to be located here for its first field hearing was because of the 14 cities and towns across our state who have made this commitment to a bold, 100 percent renewable energy transition. So looking forward to their testimony as well, and I appreciate the exchange because I think there are already a number of different areas in which the committee, I suspect, will follow up, that this will be the beginning of a conversation, not the end, for regulatory reform, something that I know interests the Ranking Member and me as well in terms of modernization and so forth.

I want to talk a little bit about the legislative session this past year. A lot of the conversations we are having right now in Washington are around the just transition and how do we make sure that folks who are working in conventional energy and fossil fuel production can transition to a stable job. My sense of it is that the legislature actually took some steps this past session on this front: House Bill 19-1314, Just Transition From Coal-Based Electrical Energy Economy (that you signed into law a few months ago). I am

wondering if you can share some lessons learned from that particular piece of legislation, how it is being implemented, and perhaps takeaways that we can glean at the Federal level.

Governor POLIS. I believe that Colorado is the first state in the nation to formally establish an Office of Just Transition to take a look at all of the programs and funding within relevant state agencies specifically through the lens of supporting communities and workers that are impacted by a changing energy sector. There are enormous opportunities in clean and renewable energy. The challenge is how do we align those opportunities with people who work in the fossil fuel sector.

We are convening broad perspectives to inform what kinds of programs and funding we should be doing to do right by Coloradans. There are workers with unique skills and expertise in energy. Many of that ports over to the clean energy economy or other fast-growing sectors, and we need to make sure that the workers are part of building our clean energy economy.

We also have to look at the impact on communities that are disproportionately related to coal. For instance, in Craig, Colorado, the largest employer is the coal plant there. We want to make sure that we can create a future that works for Craig rather than keep our head in the sand and allow the larger economic forces to hurt not just the workers but continue to hurt the climate.

Mr. NEGUSE. I appreciate that, Governor, and I think that might be an area in which we could follow up with your policy team in terms of replicating some of what you have done at the Federal level. Your point about there being immeasurable opportunities in the renewable energy sector is well stated and something we heard yesterday when we were touring one of the Federal labs in particular, just about the growth potential and a manufacturing facility that is being opened in Ohio, in the heartland of America, for solar built here in the United States, so a lot to follow up on that front.

I want to also ask you about another bill that was passed this session, and that is Senate Bill 19-236, which you mentioned in your written testimony. This is around the social cost of carbon and ensuring that that is playing a role in utility planning at the Public Utilities Commission and the Department of Regulatory Agencies. I am curious if you can expound on the bill, the basis for the bill, the impetus for it and how it is being implemented, and whether it has had an impact yet in terms of the ERPs being filed by the regulated monopolies.

Governor POLIS. Sure. Again, first to further elaborate on your previous question, when you look at, for instance, areas that have high employment and coal power production, inevitably they lay along rail lines. So you look at what other types of opportunities in advanced manufacturing can have a sustainable competitive advantage because of the location, because of the availability and training of the workers, because of the access to rail for moving products.

You mentioned the social cost of carbon. A traditional approach in any economics course taught here at the University of Colorado or other universities talks about economic externalities and how do you measure them, right? So the issue with coal power production

is that the true cost of coal—namely, the climate cost, air pollution cost—is not factored into the price that is received. So it is simply an effort at the state level to make sure that our regulators include the social cost of carbon, trying to account for the externalities of production through coal power.

Mr. NEGUSE. I know my colleague, Representative Casten, is working on a bill similar to what Colorado has done, so we look forward to partnering on that front.

Governor POLIS. We would appreciate Federal examination of economic externalities, environmental and climate related, and using the social costs of carbon in evaluating those at the Federal level would be a big step forward.

Mr. NEGUSE. Thank you. Thank you, Governor.

I yield back the balance of my time.

Chairwoman CASTOR. Thank you.

Well, I am pleased to welcome my colleague from the Energy and Commerce Committee, who I have served with for a number of years, a real outspoken advocate for climate solutions. Thank you, Congresswoman DeGette, for coming over and joining us this morning. You are recognized for 5 minutes.

Ms. DEGETTE. Thank you so much, Madam Chair, and thank you for letting me waive on to this committee.

And thanks also to my wonderful and new colleague here from the 2nd Congressional District. I am really proud of him for being a member of the Select Committee.

As the Chair said, I am a member of the House Energy and Commerce Committee with you, and the Natural Resources Committee with Congressman Graves and Congressman Neguse. These are the two committees that are going to be writing the legislation based on this committee's findings. So I was really honored to be asked to join you today, and I am very proud of our wonderful governor who I served with for many years in Congress, and I am glad you are here today because Colorado really is one of the national leaders in addressing climate change.

I want to talk about one specific issue that we are grappling with, and that is Colorado's methane waste standards. You know, methane is the primary ingredient of natural gas, and as such, it is used to heat and provide electricity to tens of millions of American homes. But when methane is wasted in the environment, it is 80 times worse than carbon dioxide in its short-term impact on the climate.

Now, Colorado has strong methane waste prevention rules, and the EPA and BLM emulated our rules under the Obama Administration. But now the Trump Administration is gutting the EPA and BLM methane rule. So I am working on legislation to pass the Methane Waste Prevention Act that reinstates this important rule at the national level.

Governor, I am wondering if you can tell us how important it would be for Congress to enact strong methane waste prevention requirements at the national level to help supplement what Colorado is doing.

Governor POLIS. You know, the Methane Waste Prevention Act would reinstate the Methane Waste and Pollution Prevention Standards that were established by the BLM and EPA in 2016, in

addition to requiring the Bureau of Land Management to issue new rules to further reduce the waste of natural gas from Federal leases and to enhance reporting requirements for new and existing wells.

As you know, emissions of methane and other pollutants associated with fossil fuel development contribute to the threat of climate change, as well as air pollution, and also are a waste of valuable resources belonging to the American public. Congress should, at the very least, reinstate the standards established in 2016 that I would add are in many ways based on Colorado's first-in-the-nation emission rules. We are going further in Colorado with Senate Bill 181, which takes additional steps to minimize emission of methane and other pollutants from the oil and gas production process.

Ms. DEGETTE. And has the implementation of those standards gone pretty smoothly?

Governor POLIS. Absolutely. Colorado continues to have strong growth in all economic sectors, and as I said, we are using that as a building block for additional efforts for methane reduction and other pollutant reduction with the new legislation that was passed this last session.

Ms. DEGETTE. Thank you. One of the other issues that I have been reading about and is an interesting issue is trying to take carbon out of the atmosphere, and one of the ways we do that is actually through protecting national forests and other public lands.

[Applause.]

Ms. DEGETTE. And the Colorado Parks and Wildlife Department estimates that the total economic contribution of outdoor recreation is about \$62 billion statewide, and it has created more than 500,000 jobs. Of course, it also protects forestry and other places that can really help with carbon reduction.

I am wondering if you can talk for a minute about investing in sustainable economic drivers like outdoor recreation in places like Colorado.

Governor POLIS. So, we formed a Climate Cabinet, which is an interagency working group of all the agencies working on climate, not just the agencies you might expect like the Department of Energy and Transportation, but Department of Agriculture and Department of Natural Resources, because you are absolutely right. Among the many reasons for protecting our public lands, of course, is that they are enormous economic drivers of jobs in Colorado, a big part of our quality of life and why we choose to live here, yet another purpose is carbon sequestration.

Ms. DEGETTE. That is right.

Governor POLIS. It makes for healthy forests and healthy soil.

Ms. DEGETTE. And as you know, Governor, Congressman Neguse and I have a set of companion bills. One of them used to be your bill when you were in Congress, the CORE Act. The other one is my Colorado Wilderness Act that, if passed together, these bills would protect about a million acres of Colorado wilderness and BLM and Forest Service land.

Do you think we should be doing more in Colorado to protect our incredible outdoor recreation resources?

Governor POLIS. Yes. I would encourage the Committee on Natural Resources to continue their work on establishing additional

wilderness areas both in Colorado as well as other areas of the country. The economic benefits to Colorado of our public lands, protecting the famed training grounds of the 10th Mountain Division in Camp Hale, and also as part of the overall climate solution with regard to sequestration.

Ms. DEGETTE. Thank you so much.

Thank you, Madam Chair.

Chairwoman CASTOR. Well, thank you, Governor, for helping us kick off our first field hearing of the Select Committee on the Climate Crisis. How appropriate on Colorado Day. Thank you very much for your testimony. Thank you for your leadership. Keep up the good work.

[Applause.]

Chairwoman CASTOR. Now we will move to our second panel. We will give them a minute to come forward.

[Pause.]

Chairwoman CASTOR. Without objection, all witness statements are hereby entered into the record.

Can we come to order, please? Let's have order in our committee room so we can get to our next panel.

I would like to welcome some of our local leaders who are going to give us their expert testimony here, so let me introduce them to you.

The Honorable Suzanne Jones is the Mayor of Boulder, Colorado, and has served as a member of the Boulder City Council since 2011. In addition to serving as mayor, she is also the Executive Director of Ecocycle, a community non-profit focused on recycling, composting, and other zero-waste efforts. Previously, Mayor Jones was the Central Rockies Regional Director at the Wilderness Society.

The Honorable Wade Troxell is the Mayor of Fort Collins, Colorado. Mayor Troxell was elected in 2015 and is now serving his second term. In addition, he is an Associate Professor of Mechanical Engineering and the Director of the Center for Network Distributed Energy at Colorado State University.

Mr. Cary Weiner is a state energy specialist at Colorado State University Extension and the Director of CSU's Rural Energy Center. Mr. Weiner helps Colorado residents make informed decisions about energy solutions. He conducts economic feasibility assessments for on-farm renewable energy and conducts community and local energy assessments.

Mr. Chris Wright is the Chief Executive Officer of Liberty Oilfield Services. He is also the Executive Chairman of Liberty Resources. Previously, Mr. Wright served as the Chief Executive Officer of Pinnacle Technologies.

And Ms. Heidi VanGenderen is the first Chief Sustainability Officer at the University of Colorado at Boulder. Previously, she was appointed by President Obama to serve as the Director of Public Engagement and External Affairs at the U.S. Department of Energy. She has also served as a senior advisor on climate change and energy for former Colorado Governor Bill Ritter, where she helped develop Colorado's first Climate Action Plan.

[Applause.]

Chairwoman CASTOR. Welcome to all of our witnesses.

[Applause.]

Chairwoman CASTOR. Mayor Jones, you are now recognized for a 5-minute presentation.

**STATEMENTS OF SUZANNE JONES, MAYOR OF BOULDER, COLORADO; WADE TROXELL, MAYOR OF FORT COLLINS, COLORADO; CARY WEINER, DIRECTOR OF COLORADO STATE UNIVERSITY'S RURAL ENERGY CENTER; CHRIS WRIGHT, CEO OF LIBERTY OILFIELD SERVICES; HEIDI VANGENDEREN, CHIEF SUSTAINABILITY OFFICER FOR THE UNIVERSITY OF COLORADO BOULDER**

**STATEMENT OF SUZANNE JONES**

Ms. JONES. Chair Castor, Ranking Member Graves, and distinguished members of this Select Committee, thank you so much for coming to Boulder for this opportunity to testify.

I am Suzanne Jones, Mayor of Boulder, and I am honored to share this panel with my esteemed colleague to discuss our climate accomplishments and talk about galvanizing a clean energy future.

Like most cities, we are passionate about our community and its future, but already climate change is taking a toll. Temperatures in Colorado have risen significantly. The number of days over 95 degrees has doubled since 2000 and is on pace to double again. In the past 20 years we have had four costly wildfires in the Boulder area, and floods in 2013 caused extensive damage across Boulder County and some \$4 billion of damage in the State of Colorado.

So, we anticipate continued drastic changes to our environment, economy, and way of life unless we, at all levels of government and across all sectors, act decisively now. First we must quickly transition to 100 percent renewable energy. At the same time, we must electrify all aspects of our lives, from heating our buildings to powering our transportation, and we know these actions will result in significant benefits beyond just emission reductions. If we remove air pollutants, we save on health care costs. When we stabilize utility costs, we can pass those savings on to households; and, of course, we are creating more jobs and new technologies. So we should seize the power, the economic potential of this transition.

And we have already begun this work. Here in Boulder, we have been leading on climate action in numerous ways. With repeated direction from our voters, we are actively exploring the creation of a city-run and community-owned electric utility so we have more control of our energy future. We co-developed the National Energy Advising Model, with 18,000 participating homes and businesses. We are now saving millions of kilowatt hours per year.

We developed an aggressive building code, resulting in more than half of our newly-built homes in recent years being net zero. We have one of the highest per capita rates of solar energy in the country, with 39 megawatts currently installed in homes and businesses.

We co-founded a 28-member coalition of Colorado cities and counties called the Colorado Communities for Climate Action, or CC4CA, and together we are successfully advocating for climate action at the state legislature.

Also, using compost and other regenerative agricultural techniques, we are implementing state-of-the-art carbon sequestration efforts designed to pull carbon out of the atmosphere while also improving soil health and agricultural productivity. And we have reduced greenhouse gas emissions 16 percent even as our population and economy grew.

While we are very proud of these accomplishments, we have so much more to do, and we have some lessons to share that we have learned along the way.

First off, we need systemic change. Choosing a low-emission lifestyle must be easy, appealing, and make financial sense. We cannot continue to rely on voluntary behavior change alone. Systemic change means reimagining the underpinning laws, infrastructure, and economy of our entire energy system.

Second, this must be a just transition. As we discussed, it must involve fossil fuel-dependent communities. It also needs to address vulnerable populations who are particularly impacted by declining air quality, rising food and energy costs, and extreme weather events. So racial and economic equity must be at the center of all climate work.

[Applause.]

Ms. JONES. Third, we need new robust financial tools for climate adaptation projects that balance up-front costs with the long-term benefits.

Fourth, despite our successes, progress has been too slow. Not only must we address additional sectors such as material management to reduce waste and create circular economies, we also know that carbon capture and sequestration is now essential.

Finally, the scale of the climate crisis demands decisive state and Federal action. As discussed, the city is thrilled that we have a dozen new climate and energy laws in the State of Colorado, and we are proud to have participated in their creation and passage, but we need more. Moving forward, the city joins CC4CA in advocating for implementing the Colorado Climate Plan, increasing consumer energy choice, strengthening oversight of oil and gas drilling, including upholding local drilling regulations and moratoria, and other efforts to limit global temperature rise.

And at the Federal level, we support efforts to achieve systemic, long-term emission reductions and promote the clean energy transition, including leveling the playing field for all energy sources, making substantial investment in clean energy infrastructure, including advanced grids, battery storage, and EV charging. We support expanding fuel efficiency and emission standards for both light and heavy-duty vehicles, pricing carbon emissions through a carbon tax or a cap and trade program, and finally expanding support for healthy soil and carbon sequestration efforts.

Let me end by expressing my deep appreciation to the committee for elevating the urgency of the climate crisis. Throughout our nation's history, the Federal government has from time to time stepped up to major environmental crises. Whether it was the Dust Bowl, whether it was the burning of the Cuyahoga River, whether it was the hole in the ozone, we have done it before and we need to do it again. It is really time for Federal action to help harness our country's innovation and address this existential crisis. And if

we do so and do so quickly, we will realize lasting benefits to our environment, public health, and our economy.

So let's be bolder, as we say here. [Laughter.]

Ms. JONES. And on behalf of the Boulder community, thank you so much for this opportunity, and I look forward to your questions. [The statement of Ms. Jones follows:]

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**Testimony of Suzanne Jones  
Mayor, City of Boulder, Colorado**

**U.S. House of Representatives Select Committee on the Climate Crisis**

**August 1, 2019**

INTRODUCTION

Chair Castor, Ranking Member Graves and distinguished members of this select committee, good morning. Thank you for the opportunity to testify today before the Select Committee on the Climate Crisis on the subject, "Colorado's Roadmap for Clean Energy Action: Lessons from State and Local Leaders."

I am Suzanne Jones, Mayor of Boulder, Colorado. I want to welcome you to our great city and thank you for holding your first field hearing here. As leaders in local climate action, the Boulder community is honored to discuss our accomplishments, challenges and ideas for addressing the climate crisis with you and the American people.

Today, I'd like to share Boulder's perspective on the importance of climate and clean energy action at the local level—and the urgent need for equivalent leadership and action at the federal level. Specifically, I will describe the urgent threats our communities face, the opportunities and benefits of responsive actions, a brief overview of Boulder's environmental and climate legacy that has given us decades of lessons learned, and my thoughts on the path forward to achieving our carbon-free energy and climate goals.

As I will emphasize, this path forward must include all of us, at all levels of government, acting decisively and urgently to combat the existential threats posed by climate change and achieve a cleaner, healthier and more just energy system.

THE THREATS

Boulder is a community that embraces innovation and seeks answers to hard problems, with our national labs, vibrant start-ups, large manufacturing companies and Colorado's flagship university, the University of Colorado. We are blessed to call this place home, and like so many communities across the country, we are passionate about protecting and preserving it for future generations.

There is global recognition and consensus that the climate is changing and will continue to change. It is now just a question of how much, when and whether catastrophic impacts can be avoided. In Boulder, the urgent threat of climate change is challenging our ability to ensure that our city remains a safe and vibrant place to live. Boulder has already experienced a range of climate-related impacts, including temperature and weather extremes, increased wildfire and drought, species disruptions and air quality concerns.

Since 1983, average temperatures in Colorado have risen more than 2 Fahrenheit and are continuing to warm, with Colorado experiencing some of the fastest-warming summers in the United States. We are seeing more destructive wildfires, more severe droughts and changing precipitation patterns. We have had four costly wildfires and a major flood in the past 20 years alone.

The 2010 Fourmile Canyon fire burned 6,200 acres and was the most destructive wildfire in Boulder County's history, burning hundreds of homes. The September 2013 flood swept away roads, bridges and homes across Boulder County, and the 2013 floods across Colorado caused nearly \$4 billion in damage. Climate scientists have found that the severe effects of the 2013 flood were enhanced by human-caused climate change. And due to milder winters, the mountain pine beetle has decimated more than four million acres of forest across the state.

There are also significant economic threats to consider, as the cost of adapting to climate change will be substantial. In Boulder County alone, analysts conservatively

estimate<sup>1</sup> at least \$100 to 150 million of additional, non-disaster costs to taxpayers between now and 2050 as a result of the need to adapt to increased threats from wildfires, heat waves and extreme weather. Specifically:

- The projected damage from wildfires will increase by almost 50% from 2020 to 2050. Mitigation efforts to prevent additional property damage to privately-owned homes alone are projected to total upwards of \$20 million.
- Increasing temperatures will impact public health costs due to extreme heat events and extended growing seasons, with potential increases in allergy and asthma symptoms.
- More intense, short-duration precipitation events will impact urban drainage systems, increasing the likelihood of localized flooding.
- The projected annual road maintenance cost per mile of road could increase from \$650 per mile historically to \$1,130 per mile by 2030 due to increased damages from higher temperatures and changes in precipitation and flooding events.
- Projected improvements to Boulder County bridges could exceed \$68 million.
- Government-owned buildings in Boulder County will experience a cumulative increase in cooling costs of 31–45% by 2030 with an increase of 54–75% by 2050.

Such estimates do not include the additional emergency response and recovery costs of future natural disasters, which we know will come. Climate change will likely also impact macro-level factors such as food prices, economic stability and increased risk of contagious vector-borne diseases. Simply put, cities can't afford the extreme weather events and climate change impacts that scientists are predicting and that we have already begun to experience.

Further, many in our communities are at a disproportionately greater risk to the effects of climate change. Seniors, children and people with lower incomes are particularly impacted by the cost of recovering from events, declining air quality and rising energy and food costs.

In short, without significantly drawing down carbon from the atmosphere, we anticipate continued drastic and possibly catastrophic changes in our environment, economy and way of life.

#### THE OPPORTUNITIES

Though the threats from climate change are daunting and the rapid shift to a carbon-free energy system will be challenging, we are presented with a real opportunity for Boulder and other cities to strengthen our communities and improve quality of life through the process of climate mitigation and adaptation.

Based on the most recent Intergovernmental Panel on Climate Change (IPCC) report<sup>2</sup>, leading cities across the country and the world are quickly mobilizing to respond to the accelerated sense of urgency combined with the magnitude of carbon reductions needed. In Boulder and elsewhere, achieving the 1.5°C temperature goal will require:

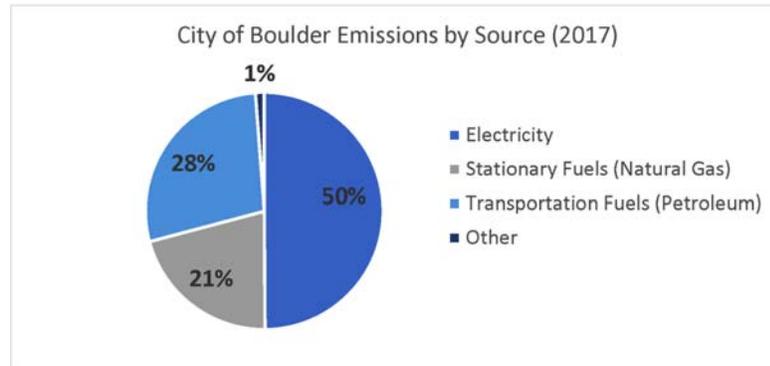
- Rapidly shifting to a carbon-free energy system;
- Accelerating existing greenhouse gas (GHG) reduction goals to the goal of achieving net zero emissions;
- Developing carbon sequestration/negative carbon strategies; and
- Focusing beyond community boundaries in setting goals and tracking progress to achieve systems-level change.

From an emissions perspective, our energy system—from how we power our homes and businesses, to how we get around—is the single-greatest opportunity to draw down carbon. We know that we need to rapidly shift to a carbon-free energy system, and we're not alone. Many localities have announced 100% clean energy or renewables goals, and momentum is building. In Colorado alone, Boulder is joined by 11 other cities and counties that have made community-wide commitments to transition to 100% clean, renewable energy no later than 2050, some as soon as 2030.

<sup>1</sup>Chinowsky, Paul S. *The Impact of Climate Change: Project Adaptation Costs for Boulder County, Colorado* (2018) <https://assets.bouldercounty.org/wp-content/uploads/2018/04/resilient-analytics-report-impacts-of-climate-change-boulder-county-colorado.pdf>.

<sup>2</sup>IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. <https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/>.

Figure 1: City of Boulder Emissions by Source



*Electrification of our entire energy system is the single greatest opportunity to reduce carbon emissions in Boulder.*

Rapidly transitioning to an energy system that runs on 100% renewable energy means quickly ending the use of fossil fuels. Our energy future will run on the abundant and increasingly cheap renewable resources like the wind, water and the sun, laying the foundation for the electrification of all our energy needs, including heating and mobility. And at the same time, we must increase the energy efficiency of homes, businesses and other buildings, and adopt the widespread use of batteries to store the energy from renewables.

This transition provides a chance to improve many aspects of our everyday lives. It will remove pollutants from the air we breathe inside and out of our homes, reducing healthcare costs for individuals and whole communities. It will also provide significant savings to customers, further protecting the most vulnerable to rising utility costs. In Colorado, new wind energy plus storage is becoming cheaper than energy from the state's existing coal plants, and new solar and wind is cheaper than 75% of the state's coal energy. As our state lawmakers have said recently, renewable energy is not the "alternative" any longer. It has become the cheapest power available, including solar plus storage for three cents per kilowatt-hour. Furthermore, we know there is plenty more wind and solar that is ready for development in our state, as evidenced by the many low-cost renewable bids still left on the table after Xcel's recent Electric Resource Plan.

While making this transition, we can also create an energy system that is more responsive, resilient and equitable. In fact, transitioning to a carbon-free resilient energy system is a priority in Boulder's Resilience Strategy, which guides our preparedness for—and ability to respond to—future challenges. Building on lessons learned as one of the inaugural cities participating in the 100 Resilient Cities program, this plan recognizes that we need a grid that's better prepared for the weather disruptions that will become more common in a warmer climate, such as stronger wind and heavier snow storms that can damage power lines. As we transition more of our energy use to carbon-free electricity, it will become even more important to protect our grid from disruptions that will harm our quality of life, limit our economic production and threaten our critical infrastructure and emergency response capability.

We also can't overlook the tools nature already provides for carbon reduction. We see important opportunities in using public and private land to sequester the carbon that's already in our atmosphere. In 2018, the City of Boulder and Boulder County jointly launched soil-based carbon sequestration initiatives. These efforts use demonstrated techniques such as the Marin Carbon Farming project's application of compost to rangelands. We are also experimenting with new and emerging strategies, such as innovative tillage, enhanced soil health practices and other regenerative agricultural techniques, to accelerate carbon drawdown and enhance local ecosystem productivity. When fully implemented, we believe these approaches could conservatively sequester 10% to 20% of local emissions. They also provide significant agricultural and ecosystem benefits such as increased resistance to drought and extreme weather events.

Finally, we have a chance to seize the economic potential of guiding this transition. We can train new work forces to power our energy future and invent new technologies that can be deployed in cities across the globe. For instance, through 2018,

every dollar the city invested in residential energy efficiency rebates leveraged about \$9.73 in private investment—local investments that ripple through our economy. In Boulder, we are increasingly seeing this challenge before us as an opportunity to make our community healthier, more prosperous and more resilient, and we will realize these benefits the sooner we take them.

**BOULDER’S ENVIRONMENTAL AND CLIMATE LEGACY**

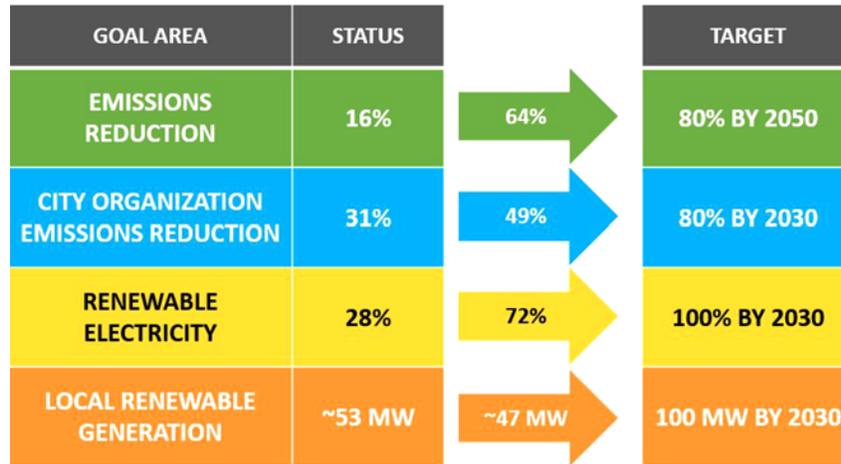
The city’s long legacy of environmental protection and climate action demonstrates that we are not starting from square one. We’ve been working on this topic for several decades and have success stories and challenges to share.

Over the last century, Boulder has consistently served as a destination for individuals defined by their creative and innovative spirit, originating some of the most progressive policies in the United States. Our history of anticipating change and enacting forward-thinking environmental policies dates back to at least 1898 with the public acquisition of mountain open space. In 1967, Boulder was the first municipality in the country to tax itself for the purpose of acquiring open space, of which we now have over 45,000 acres. Since the 1990s, Boulder’s transportation planning has been focused on reducing environmental impacts by reducing vehicle trips, expanding the network of our transit, cycling and pedestrian systems and integrating with land use planning to create walkable neighborhoods.

In the early 2000s, Boulder’s environmental consciousness turned to climate action. With our large concentration of scientists, many of whom have contributed to several IPCC reports, and an active constituency of environmentalists and outdoor enthusiasts, our community demanded that we take aggressive actions related to climate change. In 2002, Boulder City Council adopted a resolution to commit to the Kyoto Protocol goal, at a time when the federal government refused to sign on.

In 2006, the city and concerned community members published a comprehensive Climate Action Plan that addressed energy, buildings, transportation, waste and natural environment impacts. The plan was most recently updated in 2017 and includes the following specific targets:

**Figure 2: Boulder’s Current Climate Action Plan Targets**



The Boulder community has also voted on multiple occasions to tax itself to pay for climate programs and services. The city’s 2006 per-kilowatt tax collected on electric utility bills became the country’s first tax dedicated to addressing climate change, and it continues to fund our climate work today. Residents also voted to levy a trash tax that funds the city’s zero waste efforts and a Utility Occupation Tax that funds the city’s analysis of creating a local electric utility.

*Accomplishments of Boulder’s Climate Programs and Partnerships*

Since 2006, the city has been at the forefront of innovation in leading the energy transition, and through its strong partnerships with key public and private organizations such as Boulder County and the University of Colorado, Boulder continues to design new programs and approaches that have been replicated across Colorado.

In partnership with Boulder County, the city developed a national model for delivering energy-advising services that has helped more than 18,000 households and businesses in Boulder County implement energy efficiency and renewable energy improvements. Their participation in the EnergySmart and Partners for a Clean Environment (PACE) programs save 16 million kilowatt hours per year.

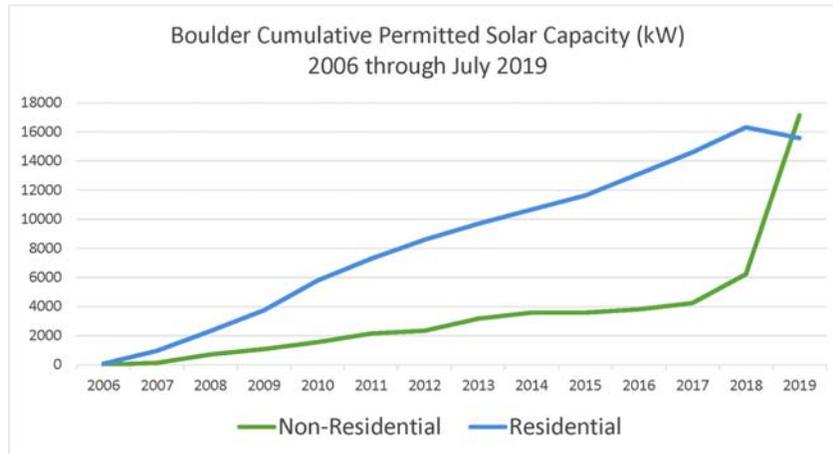
Moving beyond voluntary programs, the city enacted an energy code for new buildings that is among the most stringent nationally, with the goal of achieving net zero building codes by 2031. In the past few years, more than half of newly constructed homes in Boulder have achieved a net-zero impact. The city also requires rating, reporting and energy efficiency requirements that reduce energy use and improve the quality of Boulder's existing commercial and industrial building stock. Participating buildings have reduced their energy use by 3% from 2015 through 2018.

The city also mandated minimum energy performance standards for rental units, called SmartRegs. Through the eight-year compliance timeline, over 22,000 rental units, or approximately 96% of licensed rental units, achieved compliance with the requirements.

Boulder County has one of the highest adoption rate of electric vehicles in the state, in part by partnering with Boulder County on group bulk purchasing programs to lower the price for consumers. Called "Benefits Boulder County," this program also included e-bikes and rooftop solar.

Boulder has achieved one of highest rates of installed solar capacity per capita in the United States, earning recognition as a Platinum-level Solar Friendly Community from the Colorado Solar and Storage Association, with 39 megawatts currently installed on homes and businesses. The city's programs support widespread solar adoption in the community, including a partnership with a local credit union to provide low-interest loans on energy-efficient and solar upgrades and the city's Solar Grants and Rebates program, which provides financing for solar power installations at homes, businesses and facilities, bringing solar to more income levels.

**Figure 3: Boulder's Cumulative Permitted Solar Capacity Over Time**



*Boulder's current commercial and residential solar capacity combined is 39 megawatts.*

One of the most impactful initiatives we have undertaken, in partnership with Boulder County, is the creation of Colorado Communities for Climate Action (CC4CA), a coalition of cities and counties across Colorado that advocate together for climate-friendly policies. With a current membership of 28 cities and counties, CC4CA represents a significant portion of the state's population and has already experienced significant success in influencing meaningful climate policy at the state legislature and state agencies.

Finally, one of the city's most high-profile climate projects is municipalization, the city's effort to explore the creation of a community-owned, city-run electric utility that would bring clean, local, affordable and reliable electricity to Boulder electric customers. When Boulder residents first voted to explore municipalization in 2011, it was clear that Boulder needed to drastically reduce its emissions from the electricity generation sector in order to meet the city's GHG reduction targets. Since

then, our community has voted several times to fund our municipalization exploration process. The city's analysis to date demonstrates that local electric utilities can better reflect the values of the communities they serve and have the flexibility to offer services like microgrids that will prepare their communities for the impacts of climate change. Boulder has learned a lot from Colorado's 29 other municipal electric utilities and is actively sharing lessons learned from this effort with other cities considering municipalization, such as Pueblo, Colorado.

Through these actions, and through the addition of renewable resources by our current electricity provider, Boulder achieved its 2020 GHG emissions reduction target of 16% below 2005 levels in 2017—three years early—even as our community saw growth in population, jobs and economic activity. Achieving this reduction is largely attributable to two key factors: mitigating the increase in demand associated with population and economic growth through strong building codes and incentive-based efficiency programs, and reduced grid emissions due to state-level utility renewable energy standards and deployment of local solar.

Now, in recognition of the challenges ahead, the city and county recently declared a “Climate Emergency.” This declaration comes as the city kicks-off a new process to mobilize city residents and businesses to do everything within our grasp to tackle the climate crisis. It's not just up to city and county governments alone to address the local causes and impacts of climate change—we need our entire community's participation, too. I believe the Boulder community is up to the task.

#### LESSONS LEARNED IN THE TRANSITION TO CARBON-FREE ENERGY

I am proud of Boulder's accomplishments and the progress our community has made in transitioning toward carbon-free energy, reducing our emissions and planning for a resilient future. We also know that we still have a long way to go and have learned many lessons along the way.

##### *Need for Systemic Change*

Many efficiency and GHG reduction strategies that communities have implemented rely on voluntary, individual behavior change. While Boulder has seen success with these programs, they also have limitations. Incentives-based efficiency programs such as rebates and energy advising tend to influence a resident or business to choose a better technology when they are already considering an improvement project, but they are generally insufficient in motivating someone to undertake a project they were not otherwise considering. Mechanisms such as toll roads and high-occupancy vehicle lanes create some behavior change; yet, a key challenge is ensuring persistence of the change. Over time, behaviors tend to revert to what is easier or more convenient. Systemic change, to the point where the good choice is the only choice, or at least the easiest and simplest choice, is the only way to ensure persistent behavior change. And systemic change is not something Boulder—or any city—can do alone.

##### *Just Transition Must Be at the Center of All Programs and Policies*

We have found that participation in voluntary, incentives-based programs tends to be limited to more affluent residents and businesses, leaving a significant portion of the community underserved, including renters and lower-income residents. Regulatory approaches, such as Boulder's energy codes and performance standards for buildings, must balance the amount of savings that can be achieved against creating undue financial burden for residents or businesses. The cost of converting an existing building from gas to electric, especially in older buildings that may lack the needed electrical infrastructure, is a significant financial burden and raises significant equity concerns.

As a community, we need to ensure that all our buildings and systems remain resilient as the climate continues to change; that every community member prospers, remains healthy and can enjoy a good quality of life; and that our economy remains strong. Equity and resilience must be the foundation of our path forward.

##### *Current Financial Mechanisms Are Inadequate*

Due to the need to balance the financial burden of regulation with the intended goals, regulatory approaches such as building codes tend to be limited to lower-cost, short-payback upgrades. Cities do not control or have enough resources to direct or manage the enormous changes in infrastructure needed to transition to a carbon-free energy economy on their own. New, robust financial mechanisms are needed to achieve deeper savings. Resilience will need to be a growing priority for public investment, and equity must be central to all planning and deployment to avoid continued adverse impacts to our most vulnerable communities.

*Our Progress Has Not Been Fast Enough*

Perhaps our greatest lesson learned is that our progress, while substantial and ahead of schedule, has not been fast enough. Our existing public and private sector commitments are insufficient to stabilize climate, and energy-related emissions reductions will not alone achieve climate stabilization. The IPCC report tells us that carbon recapture is now essential if we are to avoid the worst of predicted climate impacts. In addition, we know that other significant warming factors beyond energy and transportation must also be addressed, for example, by pursuing regenerative agriculture practices and a circular approach to materials use that prioritizes reducing, reusing and recycling and composting.

*Solutions Must Be Replicable*

Given that local action alone won't come close to adequately addressing climate change, Boulder has worked hard to coordinate and lead initiatives that can be replicated in other communities. Our city participates in several global and national coalitions, including the Urban Sustainability Directors' Network, Carbon Neutral Cities Alliance, the Under 2 Coalition and the Mayors' Compact. These efforts allow Boulder to interface with other cities, learning and sharing best practices. We've learned that our actions are most effective when they are replicable for other communities.

## THE PATH FORWARD AT THE LOCAL LEVEL

Urgent, large-scale change is needed at all levels and in all sectors of society, with cities continuing to play a critical role in the path forward. In terms of making this transition, we largely know what needs to happen.

Half of Boulder's current GHG emissions continue to come from electricity generation and use, making continued investment in solar and wind power a high priority. Recognizing the central role of clean electricity, Boulder will continue to take innovative actions to make this transition. We are committed to 100% renewable electricity by 2030, 100 megawatts of local generation by 2030, and emissions reductions aligned with or more aggressive than the State of Colorado's goal of 80% emissions goal by 2050. I expect that cities across the country will continue to join in making similar commitments.

Investing in enough renewable energy to supply our current electricity demands is an essential step. But to fully transition to carbon-free energy, we need to quickly shift away from natural gas and petroleum and electrify all aspects of our daily lives: how we heat our buildings, produce hot water and power our vehicles and transit system. Boulder was one of the first cities in the nation to launch efforts to develop strategies to rapidly electrify homes. Through these efforts, we have also helped organize a consortium of over 20 leading cities in the U.S. to form the "Building Electrification Initiative." This initiative is developing a technical assistance, policy development and implementation platform to accelerate building electrification nationwide.

It is important to recognize, however, that this transition will require significant investment. The cost to electrify all 18,000 single-family houses in Boulder will alone require approximately \$700 million. A critical task facing policy makers is the development of mechanisms to enable large-scale capital investments that reduce the upfront costs for these household investments and enable long-term repayment as part of improved household benefits—reduced costs, improved safety and greater resilience to climate impacts.

At the same time, the city has taken a leading role in transportation electrification. The city is currently working on electrifying our fleet of 18 local buses and mapping the strategy for the broader electrification of transit. Again, this will require significant investment. For Boulder's local bus line alone, electrification will cost nearly \$20 million. The much broader electrification of delivery vehicles, ride-hailing services and other fleets will require much greater investment across both public and private sectors.

However, switching from fossil energy to electricity in transportation and buildings also holds tremendous potential to dramatically increase grid flexibility, reduce total household and business energy costs, and reduce air pollution and GHG emissions—a concept called "beneficial electrification." A recent analysis in California found that designing new all-electric homes reduces building costs by \$1,500–6,000 and reduces homeowner utility bills by \$4,000–10,000 over 20 years. The retrofit of existing homes to high-efficiency heat pumps also provides much-needed cooling in climates that previously did not need air conditioning. Heat pumps also significantly improve indoor air quality and reduce the incidence of respiratory health conditions,

particularly in children, the elderly and other vulnerable populations such as pregnant women.

There are similar and, in some cases, even greater economic opportunities in transportation electrification. In a recent analysis, Boulder-based Southwest Energy Efficiency Project (SWEEP) estimated that due to the higher efficiencies, lower maintenance costs, avoided carbon impacts and improved health outcomes, transitioning to electric transportation in Arizona would result in cumulative net financial benefits of \$3.8–32 billion by 2050, depending on how quickly it is implemented. At a household level, electric vehicle adoption could result in the costs of personal vehicle use dropping by 50% or more.

#### BUILDING AN INCLUSIVE AND TRANSFORMATIVE CLIMATE ACTION STRATEGY

Recognizing that achieving changes of this magnitude will require the involvement of the entire community, Boulder is also embarking on a renewed climate commitment—our Climate Mobilization Action Plan—which will accelerate our targets and identify actions that will produce the greatest impact in reducing and capturing emissions.

Key to this new plan is a renewed focus on systems-level change and the formation a new network of climate collaborators. Action at this scale will require new types of partnerships with a range of public, private, academic and non-governmental entities. It will require accelerating innovation, as the rate of change now taking place—both in the pace and impacts of climate change and in technology, social perspectives and policy—requires new models of rapid development, implementation and modification of climate action strategies. It will also require grounding actions in local benefits, designing strategies that deliver tangible, local quality-of-life benefits while contributing to emissions reductions.

Cities have in many ways been on the leading edge of this work. We have helped pioneer big steps in energy efficiency and fostering the development of more renewable power. But we know we have more to do. Cities must continue their push for more sustainable building policies, take greater steps to tackle transportation emissions and better track progress to know which investments have the greatest impact. With our innovation, ingenuity and resolve, we can build prosperous and equitable low-carbon communities.

#### THE CRITICAL ROLE OF STATE AND FEDERAL ACTION

Even with the growing engagement of cities, however, the scale of the climate crisis is far too great for local or even regional collaborations to solve the climate crisis on their own. While we believe our goals are achievable, statewide, national and global steps are essential for us to meet the demands of this challenge.

As you heard from Governor Polis, during the 2019 Colorado legislative session more than a dozen new climate and energy bills were signed into law, arguably making this session the most impactful yet in Colorado's efforts to address the climate crisis. The city is very appreciative of these actions and is proud to have played a role in their creation and passage.

These new bills cover an array of issues, including: regulating emissions from the major sectors; oversight of electric-generating companies; how companies must factor climate change into their decision-making; and new regulations on how oil and gas drilling is governed in the state. While the design and implementation of these new policies will be critical to their success, we expect that Boulder's efforts will be significantly supported and bolstered by this legislation.

Continued leadership and action at the state level is essential, and Boulder will continue to serve as an active member of CC4CA to reach the coalition's goals of:

- Supporting actions to implement the 2025 GHG reduction goals identified in the Colorado Climate Plan, as well as more aggressive goals necessary to limit the increase in the global average temperature to well below 2°C above preindustrial levels, and to pursue an increase of no more than 1.5°C;
- Increasing consumer energy choice and innovation; and
- Supporting improvements to the Colorado Oil and Gas Conservation Commission's oversight of drilling and preservation of local control to adopt regulations, moratoriums or other limits as necessary.

At the federal level, we support a suite of policies and legislation to achieve deep, long-term reductions in GHG emissions and the transition to carbon-free energy, including:

- Expanded use of regulatory mechanisms to create a level playing field for all energy technologies and energy sources, by adequately incorporating the full environmental costs and benefits of different energy strategies;

- Continued and expanded investment in clean energy infrastructure, including advanced grids, battery storage and electrical vehicle charging;
- Continued and expanded fuel efficiency and emissions standards for the entire transportation sector, including both light-duty and heavy-duty vehicles;
- Market-based programs that put a price on carbon emissions, such as a carbon tax or cap-and-trade program, which require emission reductions but let the private sector determine the most cost-effective way to achieve them (for example, House Resolution 763, the Energy Innovation and Carbon Dividend Act of 2019);
- Expanded support for carbon sequestration efforts, particularly programs that support innovation and adoption of carbon sequestration in the agricultural sector; and
- Expanded use of the Natural Resources Conservation Service to support regional-scale land management that improves community resilience to climate change.

#### CALL TO ACTION

Though the challenges of addressing climate change may seem daunting, our collective response is an enormous opportunity. If we work together across all levels of government and all sectors, we can strengthen our economies, improve community health, protect our vulnerable populations and strengthen our resilience.

I want to express my deep appreciation for the select committee's leadership in elevating the urgency of the climate crisis. The federal government was essential in enacting solutions to past large-scale environmental crises—from the Dust Bowl to toxic pollution that poisoned our waters and air. It is now time, again, for a clear vision at the federal level that harnesses the innovation in our country and galvanizes action to tackle the existential climate crisis facing us. In so doing, we can realize the enormous benefits to the environment, public health and the economy that we can have today and for future generations.

As I conclude my remarks today, I want to recognize that Boulder is not alone in its efforts. Communities worldwide are stepping up to the challenge of reducing their GHG pollution and are pressing other levels of government and the private sector to do much more to combat climate change. We are proud to collaborate closely with so many leading regional and global cities working to achieve carbon neutrality, which will engender greater economic prosperity, social equity, enhanced quality of life and climate resilience for the people and businesses in our communities. We are also deeply honored to work closely with our peer communities in Colorado, our close colleagues at Boulder County, the University of Colorado and federal agencies on such an important and defining issue.

On behalf of the Boulder community, thank you for inviting me to testify today. I look forward to answering any questions you may have.

Chairwoman CASTOR. Thank you, Mayor.

Mayor Troxell, you are recognized for 5 minutes.

#### STATEMENT OF WADE TROXELL

Mr. TROXELL. Thank you to Chair Castor and Ranking Member Graves for the opportunity to address the Select Committee on the Climate Crisis. Thank you to Representative Neguse for hosting this hearing in the great State of Colorado on Colorado Day.

My name is Wade Troxell, and I am the Mayor of Fort Collins. This is where I was born, raised, went to school and have my career, and now I have the honor of serving as Mayor.

Fort Collins is a mid-sized city of 172,000 people. We are the fourth largest city in the State of Colorado. We are home to Colorado State University, with a strong, diverse economy and a deep commitment to innovation, resilience, and excellence. For context, Fort Collins was a community of 20,000 people when I was born and is now 8.5 times that size, and it is even better, more dynamic and forward-thinking. We like to think that we punch above our weight class as a city, and our collaborative approach to climate action is just one example.

Fort Collins has one of the most aggressive climate action plans and will celebrate 20 years of climate action this fall, including our unanimously adopted goals by City Council in March 2015 to reduce community carbon emissions 20 percent by 2020, 80 percent by 2030, and achieve carbon neutrality by 2050. We set these goals because it makes financial, social, and environmental sense for our community.

Fort Collins is a “plan and do” city. While aspirational goals are important, what differentiates Fort Collins is that we have translated these goals into action-oriented, pragmatic, cost-effective solutions that benefit all in our community. For example, energy efficiency programs through our municipal electric utility and Platte River Power Authority are saving businesses almost \$10 million annually from improved efficiencies, and their employees are more comfortable and productive. Efficiency and solar programs generated in excess of \$40 million in local economic benefits last year while supporting over 200 jobs.

Our climate economy strategy, along with our collaborative approach, has been a key to our progress, and I would like to share some examples.

Platte River Power Authority and its four owner communities, including Fort Collins, has led the way with a resource diversification policy calling for 100 percent non-carbon energy mix by 2030. Our community has committed to 100 percent renewable electricity by 2030 as well, as have a number of our large local businesses, many of which are technology businesses. We can transition to a clean and resilient electric infrastructure while achieving affordability, reliability, and stewardship. Near-term utility-scale investments will result in more than 50 percent of our electricity in the coming years coming from non-carbon sources with, importantly, a neutral bill impact on our customers.

Our ground-breaking Regional Wasteshed partnership with Larimer County and other municipal jurisdictions in northern Colorado looks towards a circular economy where waste is looked at as a beneficial resource. A master plan has been developed with new wasteshed diversion facilities, and supporting policies were developed to help us achieve our waste diversion goals.

We are also a leader, along with Boulder, with 27 communities in Colorado partnering to advocate state and Federal policy in a coalition called the Colorado Communities for Climate Action. This group helped pass over a dozen bills in the state legislature this past year.

These efforts and investments have led to significant results for Fort Collins. We have seen net reductions in our emissions and reduced per capita emissions 34 percent since 2005 while our population and economy have continued to grow.

With this being said, some challenges can best be addressed at the state and Federal level. I offer the following for your consideration.

One, encourage goal setting at all levels. Setting ambitious goals can help establish community direction, ensures accountability, and it spurs innovation.

Two, recognize the climate economy. Scalable integration technologies will come from our private sector partners.

Three, recognize the value of renewable energy solutions at multiple levels and at multiple scales. Systems thinking and integration must overlay these initiatives while vertically integrating with end-use prosumers. Fort Collins collaborates with industry and research partners, such as Colorado State University and the GridWise Alliance, to transform and modernize the grid to meet the rapidly transforming electric utility industry.

With a convergence of electric and transportation systems, continue our investments in multi-modal and electric infrastructure. Thanks to Federal investments, Fort Collins has doubled its transit ridership in the past four years because of MAX, our Bus Rapid Transit system, and we will be adding seven electric buses to the system in the near future. In partnership with the Electrification Coalition, we now have electric charging stations at most of our large employers throughout the city and within our municipal parking structures.

We need to encourage innovation. Fort Collins is currently featured in the Smithsonian exhibit at the U.S. Museum of American History as a place of invention. Fort Collins was one of nine award winners of the 2018 Bloomberg Philanthropies U.S. Mayors Challenge, and the associated \$1 million prize has gone towards our innovative Epic program that provides for healthy and equitable benefits for low-to-moderate income renters by improving their energy efficiency with on-bill financing of rental homes.

In conclusion, Fort Collins is uniquely positioned to demonstrate how carbon neutrality can be achieved to benefit all residents and businesses in an action-oriented, reasonable approach. I look forward to our discussion and your questions.

[The statement of Mr. Troxell follows:]

#### **Select Committee on Climate Crisis Hearing**

**August 1, 2019**

#### **Mayor Wade Troxell's Testimony**

Thank you to Committee Chair Kathy Castor and Ranking Member Graves for the opportunity to address the Select Committee on the Climate Crisis. Thank you to Representative Neguse for hosting this hearing in the great state of Colorado. My name is Wade Troxell and I am the Mayor of Fort Collins, where I was born, raised, went to school and have my career, and now have the honor of serving as Mayor.

Fort Collins is a mid-sized city of 172,000 people, home to Colorado State University, with a strong, diverse economy and a deep commitment to innovation, resilience and excellence. As evidence, Fort Collins is a 2017 Malcolm Baldrige Award Winner recognized for an unceasing drive for radical innovation, thoughtful leadership, and operational excellence.

For context, Fort Collins was a community of 20,000 people when I was born and is now 8½ times that size and it's even better, more dynamic and forward-thinking. We like to think that we "punch above our weight class" as a city, and our collaborative approach to climate action is just one example of that. Fort Collins has one of the most aggressive climate action plans and will celebrate 20 years of climate action this fall, including our unanimously adopted goals by City Council in March 2015 to reduce community carbon emissions 20% by 2020, 80% by 2030 and achieve carbon neutrality by 2050. We set these goals because it makes financial, social, and environmental sense for our community.

Fort Collins is a "plan and do" City. While aspirational goals are important, what differentiates Fort Collins is that we've translated these goals into action-oriented, pragmatic, cost-effective solutions that benefit all in our community, such as energy efficiency. Programs through our municipal electric distribution utility and Platte River Power Authority are saving businesses almost \$10 million annually from im-

proved efficiencies and their employees are more comfortable and productive as additional benefits. Efficiency and solar programs generated in excess of \$40 million in local economic benefits last year, while supporting over 200 jobs.

Our “Climate Economy” strategy, along with our collaborative approach, has been a key to our progress, and I’d like to share some examples:

Platte River Power Authority and its four owner communities including Fort Collins have led the way with a resource diversification policy calling for 100 percent non-carbon energy mix by 2030. Our community also committed to 100% renewable electricity by 2030, as have a number of our large local businesses. We can transition to clean and resilient electric infrastructure while optimizing affordability, reliability, and stewardship. Near-term Utility-scale investments will result in more than 50% of our electricity coming from non-carbon sources with, importantly, a neutral bill impact on our customers.

Our ground-breaking Regional Wasteshed partnership with Larimer County and other municipal jurisdictions looks at waste as a beneficial resource. A master plan was developed for new wasteshed diversion facilities and supporting policies were developed to help us achieve our waste diversion goals.

We’re also one of 27 communities in Colorado to partner on state and federal policy advocacy via a local government coalition, the *Colorado Communities for Climate Action*. This group helped pass over a dozen bills in the legislature this past session.

These efforts and investments have led to significant results for Fort Collins—we’ve seen net reductions in our emissions, and reduced per capita emissions 34% since 2005, all while our population and economy have continued to grow.

With this being said, some challenges can best be solved at the state and federal level, and we are excited to continue a partnership with the federal government on innovative efforts to address climate action.

I would like to offer the following considerations for the committee:

1. *Encourage goal setting at all levels*: Setting ambitious goals can help establish community direction, ensures accountability, and it spurs innovation.

2. *Recognize the “Climate Economy”*: Fort Collins is leading the way with its focus on the “Climate Economy”, which we define as a strong, stable and innovative economy based on lower carbon solutions and infrastructure. Scalable integration technologies will come from our private sector partners.

3. *Recognize the value of renewable energy solutions at multiple scales*: Utility-scale investments, distributed energy resources, and energy storage solutions, are all critical to the transition to clean energy systems. Systems-thinking and integration must overlay these initiatives while vertically integrating with end-use “prosumers”. Consequently, Fort Collins collaborates with industry and research partners, such as Colorado State University Energy Institute and the GridWise Alliance, to transform and modernize the grid to meet the rapidly transforming electric utility industry.

4. *With a convergence of electric and transportation systems, continue investments in multi-modal and electric vehicle infrastructure*: Thanks to federal investments, Fort Collins has doubled its transit ridership in the past four years because of MAX, our Bus Rapid Transit system, and we’ll add seven electric buses in the next four years. In partnership with the Electrification Coalition, we now have electric charging stations at most of our large employers throughout the city and in municipal parking structures. We are advocating for statewide zero emission vehicle standards because that will bring public health benefits and improved electric vehicle choices to Coloradoans.

5. *Encourage innovation*: Last year, Fort Collins was one of 9 award winners of the 2018 Bloomberg Philanthropies U.S. Mayors Challenge and the associated \$1 million prize for its innovative Epic Homes program that provides health and equity benefits for low-to-moderate income renters by improving the energy efficiency of rental homes.

In conclusion, Fort Collins is a wonderful community and is only getting better. Fort Collins is uniquely positioned to demonstrate how carbon neutrality can be achieved to benefit all residents and businesses through equitable solutions. Like the Fort Collins I grew up in, we continue to enjoy the quality of life that we intend to enhance and preserve for future generations. As past president of the Colorado Municipal League, I am reminded of the words of Frederick G. Bonfils: “Tis a Privilege to Live in Colorado”. I look forward to our discussion and your questions.

Attachments:

Energy Policy 2018 Annual Update Infographic is available at: [https://www.fcgov.com/utilities/img/site\\_specific/uploads/2018-energy-policy-infographic-final.pdf?1563291213](https://www.fcgov.com/utilities/img/site_specific/uploads/2018-energy-policy-infographic-final.pdf?1563291213).

Climate Action 2017 Annual Update Infographic is available at: <https://www.fcgov.com/climateaction/files/fort-collins-2017-climate-action-plan-update-report.pdf?1537204021>.

Chairwoman CASTOR. Thank you, Mayor.  
Mr. Weiner, you are recognized for 5 minutes.

#### **STATEMENT OF CARY WEINER**

Mr. WEINER. Thank you. Thank you, Madam Chair, Ranking Member Graves, and committee members. Thank you for providing me with an opportunity to speak with you here today.

I have been the State Energy Specialist for Colorado State University Extension for the last nine years and served as Director of Colorado State University's Rural Energy Center for the last seven. I have also worked as Renewable Energy Planner for the City of Santa Fe, New Mexico. In these roles, I have implemented sustainable energy measures and consulted with a variety of stakeholders on sustainable energy. My testimony today represents my own views as a specialist in the field.

In my experience, I have found that both utility-scale clean energy development and community-based, collaborative approaches to sustainable energy are key to maximizing benefits to rural areas. Driven by our mission of empowering Coloradans, CSU Extension's work has focused on the community-based, collaborative framework which I will highlight through two examples.

First, we have conducted community energy assessments for several small towns in Colorado. These assessments provide local leaders with snapshots of funding and technical assistance opportunities available to them that align with their needs and goals. We have done these assessments in farm towns, in mountain towns, and now even in a coal town. Some communities are motivated by climate change, while others just want to save money for their taxpayers.

In Buena Vista, a small but growing town in central Colorado, we engaged the local Chamber of Commerce, realtors, non-profits, energy contractors, and utilities in our assessment process. Two of our main recommendations were to switch to more efficient lighting in town buildings and to install electric vehicle charging stations near the downtown area. In doing the lighting retrofits, the town hired a local contractor, took advantage of rebates from its rural electric cooperative, and is saving an estimated \$4,000 per year in taxpayer money. In installing the EV charging stations, the town took advantage of a Charge Ahead Colorado grant from the state, supplied residents and tourists with places to recharge, and may have increased business near the charging stations while EV drivers charge their cars.

Turning to agriculture, CSU Extension has been the recipient of two USDA Rural Energy for America Program grants to conduct economic feasibility assessments for solar and wind at 60 farms across Colorado. The Rocky Mountain Farmers Union, Colorado Corn Growers, Colorado Energy Office, Colorado Department of Agriculture, and various rural electric cooperatives donated in-kind cost share to market the program statewide. Four of our participants have gone on to apply for REAP grants of their own to install solar projects, and two were successful. The Weis family out of Hol-

yoke, Colorado, for example, installed a 15 kilowatt solar array that saves \$1,500 per year on electricity for pumping water. They should recoup their investment in about 10 years.

What may seem to be modest energy savings for a given local government, farm, household, or business can add up to a strong, distributed network of environmental and economic benefits, along with a sense of independence for rural Colorado. The Garfield Clean Energy program, for example, has helped 340 businesses, 1,200 households, and 34 government facilities complete energy upgrades that have saved over \$2.2 million through an innovative partnership between local governments, a community college, and a non-profit in one of the top natural gas-producing counties in the state. The Colorado Energy Office and the Colorado Department of Agriculture have engaged numerous stakeholders through USDA's Regional Conservation Partnership Program to save over 1 million kilowatt-hours and \$100,000 across 200 farms in the state. And across the country, state Extension programs have formed the National Extension Energy Initiative to learn from one another how best to maximize impact in rural areas.

The Federal Government can strengthen community-based, collaborative approaches to rural sustainable energy in a few ways. Waiving or reducing the Rural Energy for America Program's cost-share requirement for small business energy audits could help rural businesses benefit from energy savings and provide local jobs. Continuing the Regional Conservation Partnership Program and streamlining the Rural Energy Savings Program will strengthen cooperation to help rural areas save energy and money. And restarting the pilot USDA-USDOE State Extension Energy Partnership Program or otherwise supporting Extension's capacity to meet local energy needs would be welcome. With a presence in nearly every county in the country and trusted relationships with key stakeholders, I believe Extension is well-positioned to coordinate and catalyze community-based, collaborative rural energy solutions.

Thank you again for this opportunity.  
[The statement of Mr. Weiner follows:]

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**Testimony of Cary Weiner  
State Energy Specialist  
Colorado State University Extension**

**U.S. House of Representatives Select Committee on the Climate Crisis  
August 1, 2019  
Wittemyer Courtroom, University of Colorado—Boulder**

Madam Chair and committee members, thank you for providing me with an opportunity to speak with you here today. My name is Cary Weiner. I have been the State Energy Specialist for Colorado State University Extension for the last nine years and served as Director of Colorado State University's Rural Energy Center for the last seven. I have also worked as Renewable Energy Planner for the City of Santa Fe, New Mexico. In these roles, I have implemented sustainable energy measures and consulted with a variety of stakeholders on sustainable energy. My testimony today represents my own views as a specialist in the field.

In my experience, I have found that both utility-scale clean energy development and community-based, collaborative approaches to sustainable energy are key to maximizing benefits to rural areas. Driven by our mission of empowering Colo-

radans, CSU Extension's work has focused on the community-based, collaborative framework which I'll highlight through two examples.

First, we have conducted community energy assessments for several small towns in Colorado. These assessments provide local leaders with snapshots of funding and technical assistance opportunities available to them that align with their needs and goals. We have done these assessments in farm towns, in mountain towns, and now even in a coal town. Some communities are motivated by climate change while others just want to save money for their taxpayers.

In Buena Vista, a small but growing town in central Colorado, we engaged the local Chamber of Commerce, realtors, non-profits, energy contractors, and utilities in our assessment process. Two of our main recommendations were to switch to more efficient lighting in town buildings and to install electric vehicle charging stations near the downtown area. In doing the lighting retrofits, the town hired a local contractor, took advantage of rebates from its rural electric cooperative, and is saving an estimated \$4,000 per year in taxpayer money. In installing the EV charging stations, the town took advantage of a Charge Ahead Colorado grant from the state, supplied residents and tourists with places to recharge, and may have increased business near the charging stations while EV drivers charge their cars.

Turning to agriculture, CSU Extension has been the recipient of two USDA Rural Energy for America Program grants to conduct economic feasibility assessments for solar and wind at 60 farms across Colorado. The Rocky Mountain Farmers Union, Colorado Corn Growers, Colorado Energy Office, Colorado Department of Agriculture, and various rural electric cooperatives donated in-kind cost share to market the program statewide. Four of our participants have gone on to apply for REAP grants of their own to install solar projects, and two were successful. The Weis family out of Holyoke, Colorado, for example, installed a 15 kilowatt solar array that saves ~\$1,500 per year on electricity for pumping water. They should recoup their investment in about 10 years.

What may seem to be modest energy savings for a given local government, farm, household, or business can add up to a strong, distributed network of environmental and economic benefits along with a sense of independence for rural Colorado.<sup>1</sup> The Garfield Clean Energy program, for example, has helped 340 businesses, 1,200 households, and 34 government facilities complete energy upgrades through an innovative partnership between local governments, a community college, and a non-profit in one of the top natural gas-producing counties in the state.<sup>2</sup> The Colorado Energy Office and the Colorado Department of Agriculture have engaged numerous stakeholders through USDA's Regional Conservation Partnership Program to save over 1 million kilowatt-hours across 200 farms in the state. And across the country, state Extension programs have formed the National Extension Energy Initiative to learn from one another how best to maximize impact in rural areas.

The federal government can strengthen community-based, collaborative approaches to rural sustainable energy in a few ways. Waiving or reducing the Rural Energy for America Program's cost-share requirement for small business energy audits could help rural businesses benefit from energy savings and provide local jobs. Continuing the Regional Conservation Partnership Program and streamlining the Rural Energy Savings Program will strengthen cooperation to help rural areas save energy and money. And restarting the pilot USDA-USDOE State Extension Energy Partnership Program or otherwise supporting Extension's capacity to meet local energy needs would be welcome. With a presence in nearly every county in the country and trusted relationships with key stakeholders, I believe Extension is well-positioned to coordinate and catalyze community-based, collaborative rural energy solutions.<sup>3</sup>

<sup>1</sup>In a 2010 article in *Energy Policy* entitled 'Putting Renewables and Energy Efficiency to Work', Wei and Kammen found that solar energy produces the most jobs per gigawatt-hour of energy generated (0.87), with landfill gas second (0.72) and energy efficiency third (0.38). Distributed solar and energy efficiency can typically be supported with local jobs and are often found in community-based, collaborative approaches to sustainable energy.

<sup>2</sup>Colorado Oil and Gas Conservation Commission: COGIS Database. Retrieved 7/29/2019 from <https://cogcc.state.co.us/data.html#cogis>.

<sup>3</sup>Colorado State University Extension has for over 100 years acted as an impartial consultant to the public on issues such as agriculture, natural resources, community development, and youth development. The Food & Agriculture Act of 1977 expanded Extension's scope to provide information to the public on renewable energy, and the Biomass Energy and Alcohol Fuels Act of 1980 expanded our scope to include work on rural energy. According to a 2016 article in the *Journal of Extension* entitled 'Opportunities for and Barriers to Renewable Energy Outreach in Extension', Thomas and Brain found that 26 states now have centralized or distinct Extension energy programs.

(Excerpts from 'National Energy Education Needs and Priorities: A Roadmap for the Cooperative Extension System' by the National Extension Energy Initiative, January 2018)

The National Extension Energy Initiative (NEEI) represents the primary energy professionals within the Cooperative Extension System (CES) from more than 30 states. NEEI is well positioned to assess and prioritize energy education needs that can best be addressed by CES educators/agents (with community-based education and applied research). NEEI leverages the CES network at the state, regional (multistate) and national levels by sharing expertise and fostering collective responses to a range of topics, including: energy development, energy efficiency, and renewable energy for urban and rural communities. Members of this professional affiliation group meet regularly via conference calls, webinars and annually at the National Extension Energy Summit. NEEI also seeks to partner with other organizations and agencies (e.g., USDA and DOE) with the goal of increasing the integration of CES education and research with collaborators. Areas of potential partnership include:

- Residential/citizen education on energy efficiency and conservation.
- Assistance to community organizations, local governments and public facilities with planning, priority-setting, and collaborative educational programming.
- Rural, on-farm, agricultural energy conservation/efficiency/independence, energy audits and applied research on energy consumption and evaluating alternatives.
- Small business development, including planning and tools for evaluating energy needs.
- Collaboration with State Energy Offices (SEOs) and State Energy Programs (SEPs).

CES has the ability to offer national experts, each with specific areas of expertise on a range of energy issues, problems and needs. Furthermore, our community energy education programs involve Extension educators who work closely with consumers, businesses, utilities and local government to develop and implement new sustainable energy practices. An important strength of CES is to meet unique needs with education and research at a local-community scale. CES also has developed educational materials and publications, core curriculum, and uniform outreach strategies that are often shared nationally within the land-grant university network and with other agencies and stakeholder groups.

Chairwoman CASTOR. Terrific. Thank you very much.  
Mr. Wright, you are recognized for 5 minutes.

#### **STATEMENT OF CHRIS WRIGHT**

Mr. WRIGHT. Thank you. Chairwoman Castor, Ranking Member Graves, and committee members, my name is Chris Wright. I am the CEO of Liberty Oilfield Services, a high-tech hydraulic fracturing services company headquartered in Denver, Colorado. It is an honor and a privilege to be here today.

The climate change issue is intimately tied to energy, the field that I have spent my life in. I specifically attended MIT to work on fusion energy. In graduate school at UC Berkeley, I worked on solar energy. After graduate school, I became an energy technology entrepreneur working in both geothermal energy and oil and gas.

Climate change is global, and hence the solution must be global. In the quest to reduce greenhouse gas emissions, we must be thoughtful. A rational global approach must balance climate mitigation, economic growth, energy access, and, most importantly, human well-being.

Energy matters. A lot. Throughout human history, global life expectancy was 30 to 35 years. But in the last 200 years, global life expectancy has doubled, to 72 years. Extreme poverty has dropped from 90 percent of humanity to 10 percent and falling. The growth

in human liberty and the dramatic increase in available energy are likely the two main catalysts for this tremendous progress.

Unfortunately, we still have a billion people in the world without electricity and 2 to 3 billion that still cook in the deadly fashion that our ancestors did: burning wood or charcoal indoors in open stoves, which kills 4 million people annually, per the World Health Organization. Liquid petroleum gas, or LPG, is by far the most common, clean, and safe replacement cooking fuel that also saves women more than an hour a day not spent collecting wood or dung for cooking fuel. Energy poverty is the world's greatest challenge.

As my background shows, I am for any and all energy sources as long as they are reliable, clean, and affordable, with the power to lift humans up. The enormous annual growth in global energy demand is driven predominantly by folks rising out of poverty, aspiring to lives like ours.

The U.S. shale revolution is aiding the poor abroad and at home via much cheaper energy, with annual consumer savings over \$1 trillion. It has also driven natural gas to become the number-one source of electricity in the U.S., which helps clean our air and drives CO<sub>2</sub> emissions per person down to a 50-year low.

Global gas-powered electricity is also surging, displacing coal generation and pushing down emissions. Globally, coal is still by far the largest source of electricity, followed by natural gas, hydro-power, and nuclear. U.S. natural gas exports not only lower global greenhouse emissions, they also lower particulate matter, PM 2.5, the world's most lethal pollutant, plus other pollutants in both Asia and our Western states, like Colorado, which are downwind. In fact, a recent paper by an author at NOAA concluded that Asian air pollution was by far the biggest contributor to smog in the Western U.S.

Hydrocarbons today provide a little over 80 percent of the world's energy, the same as they did 20 years ago. The U.S. Energy Information Administration projects this dropping to only a little below 80 percent by the year 2040, but with a much larger drop in greenhouse gas emissions with continued natural gas displacement of coal. Global energy consumption grew 2.3 percent last year; think millions of folks rising out of poverty. Solar and wind combined supplied less than 2 percent of total global energy last year, or less than one year's increase in global energy demand. Hence, the trajectory of greenhouse gas emissions is impacted far more by the mix of hydrocarbons than the rate of growth in renewables.

Oil production itself leads to emissions, from natural gas flaring and fugitive methane emissions. These emissions are much lower in countries like the U.S. than they are in Russia, Iraq, Mexico, or virtually anywhere else.

Oil and gas produced in Colorado has even lower emissions than the U.S. average, due to rigorous regulations on methane capture and very little gas flaring. Even as Colorado's oil production has quadrupled, VOC emissions have dropped 40 percent. This is technology at work.

Consumers dictate oil consumption. Regulatory regimes only impact where oil is produced, which leads to some counter-intuitive conclusions, like maximizing oil and gas production in the United States lowers global greenhouse emissions, and taking regulations

too far, regulatory overshoot, is counter-productive. Inhibiting production in cleaner areas like the U.S. or Colorado leads to increased global emissions as it simply moves production to less clean places. It also hands greater control of the global energy supply to countries that are hostile to the United States, such as Iran and Russia. To date, Colorado has been a shining star, extremely modern, low-emission oil and gas production that is displacing dirtier production elsewhere. Seeking territorial-based solutions that would keep U.S. fossil fuels in the ground would result in an increase in global emissions. There is no point exporting our industry and jobs while importing, not avoiding, the emissions.

Thanks for hearing me out, and I welcome any questions.  
[The statement of Mr. Wright follows:]

**August 1, 2019—Written Testimony, Colorado’s Roadmap for Clean Energy Action: Lessons from State and Local Leaders—Chris A. Wright**

Chairwoman Castor, Ranking Member Graves, and Committee Members, my name is Chris Wright. I am the CEO of Liberty Oilfield Services, which is headquartered in Denver, Colorado. We are a premier hydraulic fracturing services company. It is an honor and privilege to be here with you today to discuss Colorado’s state and local efforts to expand clean energy development.

The climate change issue is intimately tied to the energy sector, which I have spent my life working in. Over 35 years ago, I chose to attend MIT specifically to work on fusion energy. In graduate school at UC Berkeley, I worked on solar energy. After graduate school, I began my career as an energy technology entrepreneur working in geothermal energy and oil & gas.

Climate change is a global problem that requires a global solution. In our quest to reduce global greenhouse gas emissions, we must recognize the realities of the global energy market and the global economy. A rational global approach that balances climate mitigation, economic growth, and energy access objectives is required. Fortunately, Colorado’s oil & gas sector is well positioned to play its part in achieving all three priorities.

Energy matters. A lot. Throughout all of human history, global life expectancy was 30–35 years. In the last 200 years, global life expectancy has doubled. Extreme poverty has dropped from 90% of humanity to 10% and falling. The growth in human liberty and the dramatic increase in available energy are likely the two main catalysts for this tremendous progress.

Unfortunately, we still have a billion people in the world without electricity and 2–3 billion that still cook in the deadly fashion that our ancestors did: burning wood or charcoal indoors in open stoves which the World Health Organization estimates kills about four million people annually. Liquid Petroleum Gas, or LPG, is by far the most common replacement fuel (followed by natural gas) that allows clean and safe cooking while also saving women the more than an hour per day typically spent collecting wood, dung, etc. for cooking fuel. Energy poverty is the world’s greatest challenge.

As my background shows, I am for any and all energy sources as long as they are reliable, clean and affordable with the power to lift humans up. The enormous annual growth in global energy demand is driven predominantly by folks rising out of poverty, aspiring to lives like ours.

The U.S. shale revolution is aiding the poor abroad and in the U.S. via much cheaper oil and natural gas. Our shale revolution saves global consumers over one trillion dollars every year. Natural gas has become the number one source of electricity in the U.S., helping clean our air and being the largest factor in driving our CO<sub>2</sub> emissions per person to a more than 50-year low!

The U.S.’ rapid transition from being the world’s largest importer of natural gas to the third largest exporter of Liquefied Natural Gas has driven down world natural gas prices, which in turn drives growth in global gas-powered electricity, dominantly displacing coal generation. This is a major force in shrinking, or slowing the growth of, greenhouse gas emissions. Globally, coal is still by far the largest source of electricity, followed by natural gas, hydropower, and nuclear. U.S. natural gas exports not only lower global greenhouse gas emissions via coal displacement, they also lower particulate matter, the world’s most dangerous pollutant, plus SO<sub>x</sub>, NO<sub>x</sub>, and mercury in both Asia and the U.S. as our western States are downwind of East

Asia. In fact, a recent paper by an author at NOAA (National Oceanographic and Atmospheric Administration) concluded that Asian air pollution was by far the biggest contributor to smog in the Western U.S.

Hydrocarbons provide a little over 80% of the world's energy, the same as they do in the United States. The US Energy Information Administration projects this dropping to only a little below 80% by 2040, but with a much larger drop in greenhouse gas emissions as the projections show continued displacement of coal with natural gas. Global energy consumption grew 2.3% in 2018—think millions of folks rising out of poverty. Solar and wind combined supplied less than 2% of total global energy last year, or less than one year's INCREASE in global energy demand. Hence the current global trajectory of greenhouse gas emissions is impacted far more by the MIX of hydrocarbons—coal versus natural gas, for example—than the rate of growth in renewables.

One must also consider the emissions from the production of hydrocarbons. Flaring of natural gas and fugitive methane emissions are the main sources of production-related greenhouse gas emissions. It should not be surprising that both emission sources are dramatically lower in higher income/better infrastructure countries. Oil and natural gas produced in the United States results in lower emissions than oil and gas produced in Russia, Iraq, Mexico or virtually anywhere else. Further, oil and gas produced in Colorado has lower emissions than the U.S. as a whole, due to rigorous regulations on methane capture and very little gas flaring in Colorado. In fact, over the past eight years, Colorado's oil production has quadrupled at the same time as a nearly 50-percent drop in volatile organic compound (VOC) emissions from oil production. This is technology at work, coupled with the construction of new high-tech gas gathering infrastructure.

Demand for oil and natural gas is driven by consumers and is not impacted by the location of oil production. Take China, for example, which is the largest contributor to global oil demand growth, has double U.S. greenhouse gas emissions that are rising rapidly up another 50 percent between now and 2030 under the Paris Agreement. However, China's domestic oil production is declining rapidly. Consumer demand or "pull" is what dictates total oil consumption. Regulatory regimes only impact WHERE oil is produced.

These facts lead to some counterintuitive conclusions, such as:

- Maximizing oil and gas production in the United States LOWERS global greenhouse gas emissions because of our modern and closely regulated domestic industry.
- Taking regulations too far, regulatory overshoot, is counterproductive. Inhibiting production in areas with lower emission profiles (cleaner production practices) leads to INCREASED global emissions as it simply moves oil production to less clean places. It also hands greater control of the global energy supply to countries that are hostile to the United States, such as Iran and Russia.
- Colorado to date has been a shining star, having extremely modern, low emission oil and gas production that has been growing and therefore displacing less clean oil production somewhere else.
- The same is true outside of oil and gas production. For example, the U.K. lowered their local greenhouse gas emissions by driving the petrochemical sector out of their country. But they did not lower global emissions, they simply relocated them.

In conclusion, I caution against exporting industry and jobs, while importing pollution. Climate change is a global problem that requires a global solution. Seeking territorial-based solutions that would keep U.S. fossil fuels in the ground would result in an increase in global emissions as dirtier producers would simply meet market demand. At the same time, such a climate policy would undermine U.S. national security interests to the benefit of Vladimir Putin and the radicals in Iran. Thankfully, Colorado's producers are amongst the cleanest in the world when it comes to the GHG profile of oil production. We should welcome their innovation; not punish it.

Thanks for hearing me out and I welcome any questions.

Chairwoman CASTOR. Thank you very much.

Ms. VanGenderen, you are recognized for 5 minutes.

#### **STATEMENT OF HEIDI VANGENDEREN**

Ms. VANGENDEREN. Good morning, Chair Castor, Ranking Member Graves, Representative Casten, Representative Neguse, Rep-

representative DeGette. It is an honor and a privilege to be here. Thank you for the opportunity to testify, and welcome to Boulder.

My name is Heidi VanGenderen, and I am a third-generation Colorado native. I have spent over three decades now working to advance the policies, technologies, deployment, and financing of low-carbon strategies. The Chairwoman was kind enough to provide a couple of highlights of my career. I would note that my testimony today represents my own views based on my professional background.

You have heard this morning from Governor Polis and both mayors about Colorado's leadership in advancing clean energy at the state and local level. You heard about the benefits of clean energy from Colorado's rural communities, in particular from Cary Weiner. And you heard about the role of natural gas and some regulatory outlook from my colleague, Mr. Wright.

I refer you to my testimony, the written testimony, which addresses Colorado's energy economy and the policy landscape as well, and I thank my fellow panelists for covering those topics so ably this morning. I would augment their presentations only to add that the escalation of state and local policy has in good measure been spurred by the lack of action at the Federal level over the last two decades in particular.

I would note further that the best energy policy—Representative Casten and I spoke briefly about this this morning—optimally is bipartisan and trans-partisan. The economic, health, and community benefits derived from a willing diversification of our energy fuel portfolio are eminently evident in Colorado and elsewhere around the world and the country.

The Select Committee has the opportunity to demonstrate a different path, and I applaud your efforts to work on these issues in truly bipartisan fashion.

I turn, then, to the importance of leadership by example and the investment in research exemplified by the work underway by the state's flagship university, the University of Colorado. Research for all aspects of climate change and the energy transition is an extraordinarily important investment as researchers and scientists seek to provide you, the lawmakers, with accurate, science-based evidence on which to base policies, programs, and investments that can make a difference, at sufficient speed and scale.

CU-Boulder became an inaugural member of the University Climate Change Coalition, which now boasts 20 of the top-tier R1 universities from Canada, the U.S., and Mexico. Our chancellor, Phil DiStefano, recently attended a summit hosted by the University of British Columbia and was able to converse with other university leaders about combining research endeavors across universities so that those research dollars are used as efficiently and effectively as possible.

Roughly 74 percent of the University of Colorado-Boulder's research funding comes from the Federal government. Thank you for your awareness of the importance of the Federal government's role in adequately funding this critical research. While we cannot rely on technology development and applied research as the sole solution to this challenge, there is some remarkable work underway through breakthrough technologies at this university.

Three among many examples are: one, the development of a long-range methane leak detection system that is a literal game changer in finding and capping methane leaks from oil and gas production. This is now a for-profit company.

Development of nanobio-hybrid organisms capable of using airborne carbon dioxide and nitrogen to produce a variety of biodegradable plastics and fuels, literally pulling the carbon from the atmosphere toward sequestration of it. This innovation could vastly improve our ability to do just that and manufacture sustainable biodegradable chemicals and plastics.

Development of an electric vehicle charging infrastructure begun at CU-Boulder that would be embedded in roadways and allow ongoing charging of EVs as they travel among those roadways.

Three amazing examples.

CU-Boulder's work in climate science, in collaboration with the many national labs, has been noted this morning as legion, and again outlined further in my written testimony.

Last but not least, CU-Boulder also seeks to demonstrate leadership through its own operations in deployment of our campus as a living laboratory. The latter provides opportunities for our students through integrating research and education into our daily operations and creating fertile ground for innovation and entrepreneurship by bringing together our researchers, our industry partners, and venture capital, with the goal of taking applied research quickly to commercialization. The importance of partnerships like these cannot be underestimated.

Thank you. I look forward to the discussion and to answering your questions.

[The statement of Ms. VanGenderen follows:]

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**Written Testimony of Heidi VanGenderen  
Chief Sustainability Officer, University of Colorado Boulder**

**For Field Hearing on: Colorado's Roadmap for Clean Energy Action:  
Lessons from State and Local Leaders**

Good morning Chair Castor, Ranking Member Graves, Congressman Neguse, and other distinguished members of the Committee. Thank you for the opportunity to testify at today's field hearing, and welcome to Colorado.

My name is Heidi VanGenderen. I am a third generation Colorado native and I currently serve as the first Chief Sustainability Officer at the University of Colorado Boulder. I have worked for over three decades in the public, private, non-profit, and academic sectors to advance the technologies, policies, deployment and financing of low-carbon strategies.

My comments today represent the views stemming from my professional background in energy and sustainability policy, and do not represent the official positions of the University of Colorado Boulder.

Colorado is a wonderful state in so many ways. It sports immense natural beauty and natural resources, particularly in the energy realm. It is a western state where people pride themselves on individualism, but pitch in readily in community. It is a state that prides itself on health and well-being. It is a state whose people have strong political opinions and party registration is about evenly split between Republicans, Democrats and Independents. It is a home rule state where individual communities wield tremendous influence and voters aren't afraid to step up to the ballot box through initiative. And it is a state where public institutions like the University of Colorado help lead through education, research, convening power, and operational example. I will elaborate in the following.

Colorado is a state that is blessed with abundant energy resources—we are literally an “all of the above” state that is “richly endowed” with both fossil and renewable resources.<sup>1</sup>

Several important facts about Colorado’s energy economy:<sup>2</sup>

- Colorado’s crude oil production has quadrupled since 2010, and the state holds about 4% of total U.S. crude reserves.
- Colorado is the fifth-largest natural gas-producing state, and 11 of the nation’s 100 biggest natural gas fields are located in the state.
- Colorado is the top coalbed methane-producing state, and has nearly one-fourth of U.S. economically recoverable coalbed methane reserves.
- Electricity from renewable sources has more than doubled since 2010 to almost 25% of Colorado’s net generation in 2017, led by increased wind power from the state’s nearly 2,000 turbines.
- Although coal production in Colorado has declined 64% since 2005, over half of Colorado’s electricity still comes from coal-fired power plants, and annual coal production in the state increased for the first time in six years in 2017, as foreign demand for U.S. coal rose.

Colorado’s economy overall ranks agriculture, manufacturing, mining and tourism as its four top contributors. Mining represents 4.8 percent out output and 1.2 percent of jobs. It is further estimated that each job in oil and gas extraction supports an additional 4.2 indirect and induced jobs which amplifies the effects of Colorado’s fossil fuel economy.<sup>3</sup>

There is no free lunch for any source of energy, but Colorado also knows first-hand the human health effects that come, particularly, from the extraction and use of fossil fuels. Last year, there were 280 days of recorded unhealthy air quality in the state, particularly along the Front Range where two-thirds of the state’s population resides. The national average is 227 days.

As one example, a new University of Colorado Anschutz study finds that mothers living near more intense oil and gas development have a 40 to 70 percent higher chance of having children with congenital heart defects.<sup>4</sup>

Health can and should be one of the primary drivers in our collective recognition of the need (and inevitability) of transitioning to a genuinely low-carbon economy. The health of people, the health of ecological systems, and the health of all living beings should be squarely in our sights as we continue to consider and take steps to move forward from primary reliance on fossil fuels

Renewable energy in Colorado is quite a story, as it is now in many states across the country. Providing new electric generation that reduces the energy sector’s impact on public health and the environment and diversifying the state’s electricity portfolio, thereby increasing the resiliency of the electrical grid are two strong components of Colorado’s expanding renewable energy economy.

Jobs are another important part of the equation in Colorado’s diversification of its energy economy. While Colorado is far from one of the most populous states in the country with a statewide population of only 5.7 million, our state now ranks 7th in the U.S. in terms of renewable energy jobs. Approximately 17,000 workers now work in renewable energy with the solar industry employing nearly 8,000 people and the wind industry employing more than 7,000. One sector that is likely to increase quickly is in the electric vehicle (EV) space, which already employed about 3,000 people as of 2018.<sup>5</sup> Overall, the state has 57,591 people working in clean energy industries.<sup>6</sup>

Energy efficiency, as we are all aware, is one of the most critical elements in the path to ensuring a low-carbon economy. As noted, the energy we don’t use is the cleanest, least carbon intensive and least expensive of all sources. The majority of clean energy jobs in Colorado are in energy efficiency, which employs 32,036 work-

<sup>1</sup> <https://www.eia.gov/state/analysis.php?sid=CO>.

<sup>2</sup> Ibid.

<sup>3</sup> <https://www.cobizmag.com/Articles/The-economist-Whats-the-most-important-industry-in-Colorado/>.

<sup>4</sup> <https://www.cpr.org/2019/07/19/cu-anschutz-study-suggests-link-between-oil-and-gas-developments-and-child-heart-defects/>.

See also: <https://www.thedenverchannel.com/news/local-news/cu-study-finds-people-living-near-oil-and-gas-may-be-at-higher-risk-of-cancer>.

<https://www.cuanschutztoday.org/those-living-near-oil-and-gas-facilities-may-be-at-higher-risk-of-cancer-and-other-diseases/>.

<sup>5</sup> <https://www.cobizmag.com/Articles/The-economist-Whats-the-most-important-industry-in-Colorado/>.

<sup>6</sup> <https://www.solarreviews.com/news/colorado-7th-us-renewable-energy-jobs-061418/>.

ers. Nationally that accounts for 1.4 percent of all the energy efficiency workers in the US.<sup>7</sup>

#### POLICY MATTERS

Energy has been a prominent and storied part of Colorado history. That history begins in earnest with the Pikes' Peak Gold Rush in 1858 that brought unprecedented numbers of people into the region. That influx, in turn "led to powerful social, economic, and political changes that brought about the creation of Colorado Territory in 1861, culminating in the admittance of Colorado to the Union in 1876."<sup>8</sup>

A more recent story begins with a brown bag lunch convened nearly twenty years ago at the University of Colorado Denver that brought together business, non-profit, and academic sector energy representatives to explore the most effective policies that could help advance Colorado's energy economy. The top option identified was a renewable energy standards that was then, quite swiftly, declared to be "politically unviable" by many of those assembled.

Although introduced in three legislative sessions, the legislature did not pass a renewable energy standard. Instead, in 2004, Colorado became the first state to pass a citizen-initiated renewable energy standard (Amendment 37 that resulted in a mandate to the state's two investor-owned utilities to produce 3% renewably based electricity by 2007 and 10% renewably based electricity by 2015.

Xcel Energy serves roughly 78% of Colorado and had begun exploration, before the passage of Amendment 37, of wind power. Spurred by the RPS, Xcel stepped up its efforts and completed construction of the 44 turbine, 25.3 Ponnequin wind farm on the Colorado/Wyoming border. That wind farm enabled the family that owned that ranch land to both remain on their property, and provided them critical income at a time when they would have otherwise had to vacate a failing ranch. Cattle and the turbines co-exist to this day and represent a critical element of Colorado's renewable energy economy—namely, rejuvenation of Colorado's rural economy through renewable energy. You have heard more about that story from Cary Weiner who testified earlier.

Xcel Energy found its wind investments to be tremendously viable and discovered that they were on track to meet the renewable energy standard well ahead of schedule. The utility then came to visit former Governor Bill Ritter when he was elected in 2006 to not only discontinue its opposition to the renewable energy standard, but to ask the Governor's support for doubling the standard. That standard has been strengthened three times since 2004 and today is at 30% by 2020, with 3% from distributed resources.

Today, Xcel Energy is the number one wind producing utility in the country. Xcel recently came before Colorado's Public Utilities Commission with its Clean Energy Plan to reach 80% carbon free electricity by 2030 and to produce 100% carbon free electricity by 2050. That plan was codified in the state's 2019 legislative session in SB 236, signed into law by Governor Polis, which also included cooperative utilities in the mix with a 20% renewable requirement by 2030.

Partnering with utilities, rather than combatting them, represents a new kind of politics that can supersede destructive partisanship and result in mutually beneficial policies and plans that advance economically beneficial, healthful, low-carbon strategies.

As Governor Polis noted in his testimony, thirteen bills relating to strengthening Colorado's energy policies came to his desk for signature. SB 236, noted above, addressed another critical component of Colorado's evolving energy economy—namely, the many workers in the fossil fuel industries. While oil and natural gas workers have increased, along with Colorado's production, coal workers do not face the same story with the closure of several coal plants across the state.

In recognition of the state's transition away from fossil-based electricity generation, SB 236 also allows utilities to pursue securitization (i.e., using low-cost bonds) to refinance power plants so as to retire them early and also requires the PUC to consider workforce transition issues for individuals and communities that have relied on jobs in the coal sector. The thoughtful and active retraining of workers is a role in which all societal institutions can and should participate: government, the private sector and educational institutions primary among these.

Optimal energy policy is truly bipartisan and transpartisan. It is policy that recognizes its role in providing technology neutral platforms that can unleash the best of human capacity and enterprise. It is policy that recognizes the inevitability of a

<sup>7</sup> Ibid.

<sup>8</sup> <https://www.historycolorado.org/mining-industry-colorado>.

changing energy economy while recognizing the unprecedented prosperity that has been brought through reliance on finite fossil fuels. It is policy that can help bring continued prosperity to communities everywhere through support of diversifying our fuel portfolio, lowering our carbon footprint, and protecting human health. It is policy that recognizes the optimal roles of government as a partner in needed public-private partnerships that can invest the capital required for this energy transition: as a purchaser in that new energy economy; and as a regulator to ensure that all energy enterprise is conducted in sufficiently transparent and ethical ways.

Over the last decade or more, energy policies have been enacted in the United States more at the local, state and regional levels in the absence of significant action at the federal level. While this is a global challenge, that is and will be practically addressed at a very local level, recognition of the now globally-connected energy economy is also an opportunity for rejuvenated, bipartisan effort in Congress, as well as continued policy enactment, as appropriate at the state and local levels.

#### RESEARCH ALSO MATTERS

Research for all aspects of climate change and the energy transition is an extraordinarily important investment as we seek to provide lawmakers accurate science-based evidence on which to base policies, programs and investments that can make a sufficient difference.

The University of Colorado Boulder became an inaugural member of the University Climate Change Coalition (UC3) which now boasts 20 top-tier Research-1 (R-1) universities from Canada, the U.S. and Mexico. UC3 members are committed to leveraging institutional strengths to foster a robust exchange of best practices and lessons learned in pursuit of accelerating local climate solutions that reduce greenhouse gas emissions and build community resilience.

CU Boulder Chancellor Phil DiStefano just attended a UC3 Summit hosted by the University of British Columbia in Vancouver where he was able to engage in transnational conversations about how to combine research endeavors across universities so that critical research dollars are used as efficiently as possible while leveraging the respective strengths and expertise of the collaborating universities.

Roughly 74% of CU Boulder's research funding comes from the federal government. The importance of adequate support of leading edge research cannot be underestimated if we are to successfully address one of the greatest challenges, and opportunities ever faced. While we cannot rely on technology development in the applied research space as the sole solution to this challenge, there is some remarkable work underway at our university, and others.

Two among many examples in the applied space include:

- **Renewable and Sustainable Energy Institute (RASEI):** A team of CU Boulder, the National Institute of Standards (NIST) and the National Oceanic and Atmospheric Administration (NOAA) researchers led by CU's Dr. Greg Rieker has developed a long-range methane leak detection system based on CU's Nobel Prize winning frequency comb laser, which also resulted from a collaboration between CU Boulder and NIST. The system is capable of scanning several square miles in just a few minutes, paving the way to improving both safety and efficiency. The team formed a Colorado-based commercial spin-out company to transition the technology to market. <https://www.colorado.edu/mechanical/2017/01/26/cu-boulder-team-track-methane-leaks-usinglasers>.
- **Chemical & Biological Engineering:** Prashant Nagpal's research has "developed nanobio-hybrid organisms capable of using airborne carbon dioxide and nitrogen to produce a variety of plastics and fuels, a promising first step toward low-cost carbon sequestration and eco-friendly manufacturing for chemicals. By using light-activated quantum dots to fire particular enzymes within microbial cells, the researchers were able to create "living factories" that eat harmful CO<sub>2</sub> and convert it into useful products such as biodegradable plastic, gasoline, ammonia and biodiesel." <https://www.colorado.edu/today/2019/06/11/these-nanobugs-eat-co2-and-make-eco-friendly-fuel>.

CU Boulder is home to some of the most renowned climate research in the world, and was recently ranked number one in the world for geosciences. Nested in a constellation of federal labs (several of which I understand you visited during your trip to Colorado), that research includes:

- **The Institute of Arctic and Alpine Research (INSTAAR):** Tania Schoennagel analyzes the increase in wildfires in the American West over the past 30 years. Her work projects how climate change will affect the trend in coming decades, particularly with regard to the wildland/urban interface. In Congress and elsewhere, she advocates for policies that promote adaptive resilience in response

to changing fire regimes. <https://www.colorado.edu/today/2017/04/17/new-era-western-wildfire-demands-new-ways-protecting-people-ecosystems>.

- INSTAAR: One of the most cited researchers in the geosciences, James White was among the first to document the astonishing speed and magnitude of past climate change seen in ice cores. By showing that climate change in natural systems tends to happen abruptly over decades, White's work has contributed greatly to our understanding of the potential consequences of climate change within our lifetimes. <https://news.nationalgeographic.com/news/2013/12/131203-abrupt-climate-change-science-early-warning-report/>.

- Cooperative Institute for Research in Environmental Sciences (CIRES) and INSTAAR. CIRES is a partnership between the National Oceanic and Atmospheric Administration (NOAA) and CU Boulder. More than two dozen CIRES and INSTAAR researchers are at the heart of NOAA's global monitoring program, which continually tracks and studies levels of greenhouse gases in the atmosphere. Those measurements of gases, including those known to cause greenhouse warming and others involved in depletion of Earth's protective ozone layer, are the foundation of the world's understanding of past, current, and future climate change. (Carbon Cycle Greenhouse Gases group)

- CIRES: Lisa Dilling and other researchers in the CIRES-based Western Water Assessment seek to understand how climate change and variability affect water and other resources in the Intermountain West. The WWA team is working with water managers and lawmakers to understand how cities plan for and respond to natural hazards and climate change, exploring what kind of snowpack data can best inform water managers making decisions about water allocation and use, and working with ranchers to help navigate matters like drought and insurance.

- CIRES: CIRES scientists are among the most well-known experts in the world on Earth's changing frozen realms—the cryosphere. Led by CIRES Director Waleed Abdalati, an expert in remote sensing of Greenland's dynamic and melting ice, CIRES scientists track changes in Arctic sea ice, study permafrost evolution, conduct field work from the South Pole to the North Pole, and much more. The CIRES-based National Snow and Ice Data Center tracks changes in Earth's frozen realms to better understand our future: from measurements of sea-ice extent in the Arctic and sea-ice forecasting for the Navy, to discovering the climate impacts of melting permafrost.

CU's engineering, environmental design, geosciences and business programs, supported by the work of centers and institutes such as the Center for Science Technology Policy Research (CSTPR) and those noted above are also cultivating the workforce of the near-future who will literally help design, engineer, build and operate the low-carbon economy.

Students are prepared, in part, to do so through participating in our campus as a living laboratory. This refers to integrating research and education into our daily operations and creating a fertile ground for innovation and entrepreneurship by bringing together our researchers, industry partners, and venture capital with the goal of taking applied research quickly to commercialization. A brilliant and potentially breakthrough concept like Prashant Nagpal's as one example, has to be demonstrated through pilot scale deployment to prove their merit and ultimately their efficacy in the marketplace. What better place than university campuses, and the communities in which they reside, to provide that testing ground?

The imperative is clear. The work underway is remarkable and hopeful. The respective and collective roles of each sector and institution you are hearing from in the course of the work of this Select Committee are also clear. The very fact of your work through this Select Committee is an indication that congress not only recognizes the imperative, but is looking for paths to support the good work at the local, state, and regional levels across this country, and across the world. We in Colorado applaud you, and thank you.

Again, thank you Chair Castor, Ranking Member Graves, Congressman Neguse, and members of the committee, for the opportunity to testify today. I look forward to the discussion and to answering any questions you may have.

Chairwoman CASTOR. Terrific. Well, thank you all very much for your compelling testimony.

At this time I will recognize myself for 5 minutes for questions.

Mayor Jones, last week the Boulder City Council declared a climate emergency, passed a resolution declaring it so. That resolution commits to keeping the concerns of vulnerable neighborhoods

and neighbors at the forefront as we transition to the clean energy economy and kind of double down on the planning process.

There is already too much inequity across this country, and I would like to ask you, and Mayor Troxell as well, you all have your finger on the pulse of your communities. What recommendations do you have for us at the national level as we develop a national climate action plan that can be impactful to ensure that as we deploy certain resources, make certain investments, that we are lifting people, that we are treating people equally, we are not leaving anyone out?

Ms. JONES. Well, thank you, Chair, for that question. We are lucky to have a partnership with the Just Transition Collaborative here at CU to help wrestle with this very issue, and several recommendations came out of that work that I would pass on to you.

One is that I think as we embark on this huge systemic change and transition is to make sure that underrepresented communities are at the table as part of the decision-making process and their voices are heard.

Another is to make sure that the jobs, the solar energy jobs, the energy efficiency and household jobs, are going to those communities, to those workforces, low-income workers that can be trained and be a part of the solution, and so that they have access to that economic growth.

And then I would also say that we want to make sure that we are providing the solutions, whether it is solar on the roof or what not, make sure that everybody has access to that. One example that we have here in Boulder is we have a program to try to do just that, so that everyone is included in the solution and the benefits of it.

Mr. TROXELL. And I would just like to add that in Fort Collins, a priority of our Council is equity and inclusion. So we look at everything that we do through that lens for our entire community so we have a community for all, and with that we look at investment in our infrastructure as key because it does benefit all in our community.

And finally, an important part of our community is engagement, and engagement is really meeting people where they are, not coming to City Council on Tuesday night at 6 o'clock, but it is really engaging everyone where they are.

So we work closely. I would state one program in particular, working with the Center for Public Engagement at Colorado State University, it really does bring people together. It is not the loudest people in the room, not the smartest people in the room, but it is everybody in the room to have a conversation and to really get to better solutions.

Chairwoman CASTOR. Terrific.

Mr. Weiner, it is not your parents' Extension service anymore. Thank you for your concrete policy recommendations for us.

Will you expand upon that? Tell us a story, a real-world example of something where maybe you were surprised at the impact or you are hopeful for the opportunity if we scale something up on the national level.

Mr. WEINER. Thank you for that. I think working with the agricultural sector has been a pleasant surprise, engaging their inter-

est in renewable energy. I think we oftentimes think of large wind farms being planted down on farms across the United States, and then farmers getting the benefit of lease payments. But what was surprising to me was just seeing the interest in offsetting their own electricity use, noting how some of these irrigation expenses make up a pretty significant part of their operating expenses for running a farm, for example.

So when we opened up our first Rural Energy for America program grant to these folks, we had space for 30, and we filled 50 right off the bat. So I think there is a lot of interest. We didn't have as many agricultural producers succeed in their applications as we would have hoped, but that was something that has been a pleasant surprise.

Chairwoman CASTOR. And when you think about the struggles across rural America right now and so many challenges our farmers face, I think this is a very important area, and I hope the committee can focus a lot more time on this in the future.

Thank you, and at this time I will recognize Ranking Member Graves.

Mr. GRAVES. Thank you, Madam Chair.

Thanks again for all of your testimony. It was a pleasure to meet you.

Mayors, I have an important question to ask. I heard these subtle references to UC-Boulder and Colorado State University. Which one is better? [Laughter.]

Mr. TROXELL. Actually, we have excellent research universities, and I would speak to the renewable energy laboratory that actually brings together Colorado State University, University of Colorado at Boulder, and Colorado School of Mines in partnership with NREL and really working collaboratively related to our energy-related needs.

Mr. Graves. Thank you. There wasn't a right answer. All I know is I think I see Saint colors on that flag over there. [Laughter.]

Mr. GRAVES. Seriously, Mr. Weiner and Ms. VanGenderen—

Ms. VANGENDEREN. Just call me Heidi. It is a lot easier. [Laughter.]

Mr. GRAVES. Right. Oh goodness, my Dutch-German family would be very disappointed in me.

But in any case, you both mentioned something that I think is pretty important, as did Congresswoman DeGette. We talk often about reducing emissions, which is, of course, an objective I think we all share, and we need to ensure we continue on this downward trajectory. But you both also mentioned potential opportunities for sequestration, as did the legislation that Congressman Neguse and Congresswoman DeGette were working on, the role of the biogenic environment and actually capturing.

In Louisiana, one of the things that we do for sustainability is we engineer oyster reefs in a way where you can set up geometric formations to where wave energy comes in, hits perhaps a pyramid shape, sends the wave energy up instead of into our communities. Oyster reefs sequester greenhouse gases. They purify the water. They help to clean the water. They obviously provide a food source. Multiple win-win-wins as a result of those, and I think it is something that is really important that oftentimes isn't given as much

respect in this discussion that is needed. So I appreciate both of you bringing it up.

Mr. Wright, you brought up some things that were somewhat counter-intuitive, I think. You actually said—and don't let me put words in your mouth, but basically that by producing natural gas, we are actually resulting in cleaner emissions, cleaner energy solutions. Could you expand on that a little bit? Because I think particularly energy production in Colorado perhaps is cleaner than anywhere else as a result of producing natural gas here.

Mr. WRIGHT. Yes, two points on that. The first is that over the last decade, the significant drop in U.S. greenhouse gas emissions, the single largest source of that drop—there are different studies. Somewhere between 50 and 70 percent of the drop in U.S. greenhouse gas emissions has been from the huge surge in U.S. natural gas production, which has driven down the price. Coal used to be, not long ago, by far the largest source of electricity in the United States, at over 50 percent. Today it is down to about 30 percent, and natural gas has displaced it. So by burning natural gas instead of coal, it has halved the greenhouse gas emissions. That has been the biggest driver of reduction of the United States' CO<sub>2</sub> emissions.

And then where it is produced, the second half of your question, matters too. Our wonderful governor spoke about that earlier today. When you produce in Colorado, which is even better than the country as a whole, or in the United States, we are just simply much more careful about gathering all the gas, and those technologies continue to get better. I love the monitoring technology. A friend of mine is involved in that company that Heidi mentioned. If you can collect a much larger percentage of the gas, therefore less leaks out, and when you don't have the infrastructure you have to burn the natural gas, called flaring—so it doesn't release methane but it burns and releases CO<sub>2</sub> emissions. So there is much less of that in the United States, particularly in Colorado, than production almost anywhere else in the world. So given the constant demand, or whatever the marketplace demands for oil and gas, where you produce it matters.

Mr. GRAVES. I think I read recently where gas that comes from the United States as compared to Russia is 13 percent cleaner. So whenever you are using Russian gas, it results in a dirtier environment and greater emissions.

When we were at NREL yesterday, I don't remember who it was but one of the scientists said that if we had to pivot immediately to renewables, that the technology, the grid—I think you mentioned that 2 percent of the world's energy is produced from renewables—that we are simply not capable at this point of just having this automatic transition. I noted that a lot of the scientists who talked to us about trucks and ships and planes and other areas where the energy concentration of renewables and the storage capacity of batteries is not great enough.

The U.S. I think is viewed globally as perhaps not the leader on emissions reduction, but as I stated earlier, we actually are. Could you briefly compare the U.S. to perhaps Europe and our strategies for emission reduction?

Mr. WRIGHT. You bet, and maybe the biggest example here is Germany, who has certainly spent, per capita, the most of any

country in the world. They started earlier. Germany spent somewhere between \$200 and \$400 billion on the German clean energy transition. Number one, they reduced their CO<sub>2</sub> emissions over the last decade significantly less than the United States has. In fact, I mentioned the world gets 81 percent of its energy from fossil fuels. Germany gets 84 percent of its energy today from fossil fuels.

Mr. GRAVES. And is supporting Nord Stream 2 to bring in more Russian gas.

Mr. WRIGHT. But the part that concerns me the most—to me it should be always focused on humans—is Germany doubled their electricity prices from the start of their energy transition. They are today three times higher than the United States, and from their own public health data 30,000 people are killed every year, premature deaths, because of the extra costs of energy, that they don't heat their homes. That is a significant problem in the U.S. More than 10 percent of Americans report keeping their house at unsafe temperatures, both too hot and too cold, because of electricity prices; 14 percent receive disconnection notices.

So I loved all the “cough” about lower energy prices. If we could transition energy and drive prices down. It would be fantastic, but it would be a first.

Mr. GRAVES. Thank you.

Thank you, Madam Chair.

Chairwoman CASTOR. Mr. Casten, you are recognized for 5 minutes.

Mr. CASTEN. Thank you, Madam Chair.

I want to pick up on that thread, and I have to warn the crowd, I am going to nerd out here a little bit. But you and I have very similar backgrounds. I wasn't smart enough to get into MIT but went up the road to Dartmouth for engineering school and then spent 16 years as a CEO of various clean energy companies.

Mr. WRIGHT. Fantastic.

Mr. CASTEN. You didn't say this in your testimony but I would suspect you sort of intimated. One of the theories I came to early on is that we consistently make the same mistake in our energy policy that Dartmouth and probably MIT made in their alcohol policy. [Laughter.]

Mr. CASTEN. We assumed that we can regulate demand by regulating supply.

People want energy, and that led me to really focus on energy efficiency and conservation, particularly on the generation side.

But I want to talk a little bit, because I have some concerns about what you said, but I want to sort of hear your thoughts on this.

For most of the beginning of my career, natural gas was always \$3 per million BTU. It was locked in place, and the gas industry—if you could sell it for \$5, you would rather sell it for \$5. But a lot of the power sector built massive amounts of gas-fired generation in the '90s because they said at \$3, we can compete with coal. We built 200 gigawatts—that is 20 percent of our entire power fleet—gas-fired generation in about a 10-year period to chase \$3 gas.

Now, as I don't need to tell you, in 2007 the price went up to about \$12. First of all, I am assuming that you would agree with

me that that was basically a supply/demand balance that really pushed that up.

Mr. WRIGHT. One hundred percent.

Mr. CASTEN. Okay. Post-recession and post the fracking revolution, the price has gone back to \$3, and we have been basically at \$3 for the last decade. And I agree with you that that has substantially explained the demise of coal. Renewables has played a big role, efficiency has played a big role, but gas has played a big role there.

During that same 10-year period, European gas prices have been around \$7 on average, roughly speaking. There was a huge push in the '90s to build LNG facilities to export gas to Europe to chase high-cost gas, because a lot of gas producers wanted to chase that expensive gas market.

Your testimony suggested that if we export gas overseas, we will drive down the price of gas overseas. Why does supply and demand not still apply? Because we learned those lessons before, and if we raise the price of gas internationally, we will bring coal back.

Mr. WRIGHT. I appreciate very much your comments and agree with your assessment of history, absolutely. The difference is the magnitude of the shale revolution. Almost all oil and gas was originally produced in shales. It slowly, through geologic time and natural hydraulic fractures, leaks out. So before, we were just finding the stuff that leaked out and got trapped. Now we are going into the source rocks, and the reserves in the United States are just gigantic. I think \$3 is a ceiling on natural gas prices for as far as the eye can see.

The one thing I disagree a little bit with is the United States, we used to be the largest importer of natural gas 10 years ago. By the end of this year we will be the third largest exporter of LNG in the world, and we have actually meaningfully depressed LNG prices. They are down 40 percent if you take a global average of before the start of U.S. exports and today.

So, yes, we are growing the growth of demand for natural gas. Yes, supply and demand works. So more demand for natural gas should be, in theory, a push up on price. Right now what it is—that is all true, but during the years before the financial crisis we averaged 1,000 natural gas rigs drilling, and we were a large importer. Today, it has been two years before we had 200 rigs drilling for natural gas. It is about 175—

Mr. CASTEN. I guess my challenge to you, all of that might be true, and by the time we know for certain it is true, it is going to be too late to change course. If you look at the history of North Sea oil, we did a really good job of drilling when oil was expensive, and then exporting when oil was cheap, and I think most of those European countries would say that they did the opposite of buy low, sell high. If you can sell gas for \$3 in the United States, why would you possibly invest in liquefaction, storage, and shipping to sell it for \$3 overseas? You are not going to get any return on your capital. Chesapeake had a negative return on equity for most of their life.

I have a real, real concern that if the price of gas goes up, we are going to use a lot more coal in this country.

Mr. WRIGHT. A very legitimate concern. I would love to talk with you more about it offline. But the reserves and productivity of gas in the United States, there is 100 years of low-cost production at today's rates.

Mr. CASTEN. But that is a supply question. Demand still matters.

Mr. WRIGHT. One hundred percent.

Mr. CASTEN. Thank you.

I yield back.

Chairwoman CASTOR. Representative Neguse, you are recognized for 5 minutes.

Mr. NEGUSE. Thank you, Madam Chair.

Thank you to each of the witnesses for being here today, for your testimony. I can assure Representative Graves that the correct answer, when you represent the 2nd Congressional District, is that both universities are wonderful universities. [Laughter.]

Mr. NEGUSE. So I am particularly grateful to the mayor of Boulder and to the mayor of Fort Collins, the mayors of the two largest cities in my congressional district, for their leadership and for showing us the way. My hope is we can export some of what we have gleaned from your testimony to Washington as we develop our recommendations.

Mr. Wright, I do want to talk about your testimony. I reviewed it in great detail, your written testimony, and obviously your oral remarks. I disagree with your appraisal of natural gas in the context of poverty and the way in which you have characterized it in your testimony, and here is why. Most empirical studies that I have seen demonstrate that unmitigated climate change, if anything, amplifies poverty, because climate change will affect developing countries and poorer communities more than rich ones.

In the United States, the economic toll—there was a study published last April that found that inaction on climate change by the year 2090 would cost the United States \$224 billion more in economic impacts per year. That is the cost of health care, infrastructure, electricity, water resources, agriculture, and ecosystem. So I just respectfully disagree with the way in which you framed that.

But beyond the economic arguments, I want to drill down a little bit here on one of the phrases that you mentioned in your testimony, which is this notion that natural gas is, quote, "helping to clean our air." You are familiar with the acronym VOC, with volatile organic compounds; correct?

Mr. WRIGHT. I sure am.

Mr. NEGUSE. And you would concede that some VOCs are known to be directly hazardous to human health; is that right?

Mr. WRIGHT. That is correct.

Mr. NEGUSE. And some of them contribute to the production of ozone or other regulated pollutants; right?

Mr. WRIGHT. Correct.

Mr. NEGUSE. And for the benefit of the folks here, according to the National Institutes of Health, VOCs can cause irritation of the eyes, respiratory tract, dizziness, visual disorders, memory problems, damage to the central nervous system, and in some cases cancer.

Would you concede that the drilling process of hydraulic fracturing can release what are known as volatile organic compounds?

Mr. WRIGHT. Yes, it does.

Mr. NEGUSE. Okay. And just again for the benefit of the record, the University of Colorado's Institute of Arctic and Alpine Research completed a study this year determining that high levels of harmful atmospheric pollutants such as VOCs are regularly blown into Boulder County, here where I live and where so many here in the audience live, from oil and gas wells to the east. They ran over 8,000 samples for VOCs in the study, and there is no other place, program, or organization in the state that has run that many samples for these types of gases.

So given all of that, I suspect you will agree with me that fracking can cause health risks regarding air quality.

Mr. WRIGHT. All energy production involves health risks, all of them.

Mr. NEGUSE. Well, I would disagree with you there. Obviously, a big focus of our work over the course of the last two days has been visiting with scientists that are part of the renewable energy transformation, and I can assure you that the health risks from the various sources of energy that we have been looking at, solar and wind, of course, pale in comparison to the health risks caused by hydraulic fracturing.

I will just tell you that a 2016 Johns Hopkins epidemiological study of more than 400,000 patients showed that there was a significant association between fracking and increases in mild, moderate, and severe cases of asthma.

Are you familiar with which industry is the top producers right now, a top producer I should say, of VOCs along the Front Range?

Mr. WRIGHT. The largest producer of VOCs in Colorado is naturally occurring sources.

Mr. NEGUSE. Well, I disagree with you there, and perhaps we will discuss this further offline, but from the studies we have seen—

Mr. WRIGHT. I think that is reasonably well documented.

Mr. NEGUSE [continuing]. The oil and gas industry is the top producer of volatile organic compounds along the Front Range, which is a region that has failed to comply with Federal air quality standards for more than 15 years. So this notion that problems in our ozone here, emissions and so forth, are being caused by emissions in Asia—I am sure you are familiar with this, that just in March of this year, our air quality in Denver was three times worse than Beijing.

So I just would implore you, and I certainly implore others who are watching, to read the data, to talk to people in the communities that are being impacted here in Boulder County, elsewhere across the state. It is a very real, visceral issue for them. My wife and I have an 11-month-old daughter. We want to make sure that she is able to breathe clean air here in Colorado, in the place that we are lucky to call home.

So with that, I would yield the balance of my time.

[Applause.]

Mr. WRIGHT. May I respond?

Chairwoman CASTOR. Thank you.

Before we turn to Congresswoman DeGette, for our panel and for the audience, we would like to have another round of questions, if you all are willing to do that. Good, okay.

Congresswoman DeGette, you are recognized for 5 minutes.

Ms. DEGETTE. Thank you so much, Madam Chair.

Well, I think I would like to follow on to Congressman Neguse's questions about fracking, very briefly, because as well as the VOCs that result from fracking and which we are trying to deal with on the Federal level, fracking also, of course, has the fracking fluid that can potentially contaminate ground water. So last Thursday I reintroduced the "FRAC" Act, which I have been doing for some years. What that does is it eliminates the Halliburton loophole that was enacted in the 1990s which exempts only the oil and gas industry from reporting the chemical components of the fracking fluid from the Safe Drinking Water Act.

So I guess there are a lot of environmental impacts, as Congressman Neguse noted, that come from fracking. So as a result, Mayor Jones, I know that the City of Boulder recently extended its fracking moratorium. I am wondering if you can talk about the municipality's reasons for this moratorium and what it has done for your local economy here, pro or con.

Ms. JONES. Thank you, Congresswoman DeGette. We have a lot of concerns in our community with fracking from two angles. One is, as Congressman Neguse eloquently stated, there is a lot of public health impacts that come from oil and gas drilling and exploration, and I will just note that the Boulder County oil and gas inspector did a study to look at leaks from oil and gas production and found a 65 percent leak rate, which prompted the industry, to their credit, to go and do a big push to fix those leaks. But two years later I went back to see how we are doing, and it is a 45 percent leak rate because new leaks happened.

I guess my point is there are a lot of air pollutants, both methane, which deals with climate, and VOCs, which address public health, that come from oil and gas production, and it is a concern of our community; we are downwind.

The other side of that is our economy is very much based on a high quality of life, our wonderful vistas, our wonderful outdoors, being able to recreate and breathe clean air, and a lot of companies are attracted to bring their companies here because of that. We have a very robust economy, and fracking is at odds with the basis of that.

Ms. DEGETTE. So one thing, Colorado has actually passed some of the most stringent laws around fracking in the last few years, but yet you are saying this leaking and some of these other issues, it still occurs even despite the strong laws and, frankly, the commitment of most of our oil and gas companies here in Colorado to comply with those laws.

Ms. JONES. Yes. The methane rules that were passed were a great step forward. We appreciate industry's agreeing to some of that. However, yes, the leaks continue, and we know how much more potent methane is than CO<sub>2</sub>, and we know that when leaks get in the 10 percent range, that the benefits of natural gas as compared to coal are drastically reduced.

Ms. DEGETTE. So let me ask you this. Would it be important for all of these laws, the methane, the CO<sub>2</sub>, the Safe Drinking Water Act, it is important to have Federal legislation that sets some kind of minimum standards? Wouldn't that be accurate?

Ms. JONES. Absolutely.

Ms. DEGETTE. Okay. I just have one last question for both of our mayors, because in the light of Congress' unfortunate inaction on climate change issues the last few years, which we hope to change with all due expediency, local and state governments really have stepped in, and your testimony today is perfect evidence of how that has happened. But I am wondering whether you can tell me, in your view, if local and state governments can do it without some kind of strong national standards.

Ms. JONES. Do you want to go first?

Mr. TROXELL. You know, I think we have to work in partnership with Federal, state, and local governments. I represent my community, and we are committed, and we are committed in a way that we keep our heads down and keep working on what works for our community.

Ms. DEGETTE. Can you do it without us, though?

Ms. JONES. No.

Mr. TROXELL. No. That is where it doesn't stop at our local boundaries, and that is where working together—and that is where I think there is state and Federal participation as well.

Ms. JONES. I would just add that we absolutely need your help, please. We have a window of time that is shrinking if we are going to avoid the worst impacts of climate, climate change, and I will just note that local municipalities cannot afford the extreme weather events that we are predicted to see, right? So we definitely need national action, and I will note that putting a price on carbon at the national level would be one of the most useful things you could do, because it could drive all the markets, the technology, the innovation in all of our communities.

[Applause.]

Ms. DEGETTE. Thank you very much.

Chairwoman CASTOR. We will go to a second round of questions, and thank you for your thoughtful questions, members.

Congresswoman DeGette, when you said unfortunate, and you were talking about Federal policy inaction, it struck me that we have really struggled with the Trump Administration's rollback of energy efficiency standards, rollback of fuel economy standards for the cars that we drive. America has always been a leader globally in pushing, pressing for the most modern technology. Under the Obama Administration, again, we set higher fuel economy standards for our cars, only to be rolled back by the Trump Administration, and many of the automobile manufacturers didn't want them to be rolled back. Just last week California and a number of the automakers decided, well, we can't recede, we can't cut and run in America, we have to move forward because we have to compete for the modern electric vehicles of the future. Otherwise, they will be built in China and in Europe. No, this is the United States of America, we have to continue to be the leaders.

You all—I am going to go to our mayors again—you have been leaders here locally and have a lot of lessons that we can take

away when it comes to energy efficiency and cleaner vehicles, electric vehicles. Can you share with us what you have been doing and what you would reiterate again for the record how important national policy is and what that would mean to your communities and to communities across the country?

Mr. TROXELL. Well, I will just start off. You know, we have to do this in partnership as well, and I think regulatory policy is important, but that is not the only thing. I see our community and our citizens really doing the right thing.

Chairwoman CASTOR. I think citizens are hungry for it, and they know they can put money back in their pocket, right? Yes.

Mr. TROXELL. They can see that, and that is where I think it is a partnership. That is why we focus on the climate economy. With a global issue, we intend to build businesses that serve the nation and the world. That is the way we do it strategically in our community.

Ms. JONES. Well, I will note that, for example, take electric vehicles, we are very proud that EVs make up about 10 percent of the new car sales in Boulder, high above the state average and the national average. Part of that is because people care, and people can look at the savings over the life of the vehicle and realize that.

But the other reason is that we have state and Federal tax credits that have made that much more affordable. We have also done bulk purchasing programs with Boulder County in order to deliver those savings to households. So we are working hard to do that.

We also have building codes that require wiring to be in place for charging. We are investing in infrastructure around the city and working with our governor on the state level.

So I think this is a team effort, but I think the Federal role in providing those tax credits is key. I will also note that I believe there is a bill being proposed that would raise the cap on the number of vehicles that a company can sell before they lose that tax credit, and it seems to me that it would be very useful to raise that cap so that the leaders in the industry aren't penalized by their success, because that help to even the playing field on this new technology is paying off. It is paying off right here in Boulder.

Chairwoman CASTOR. So, Ms. VanGenderen, you were at DOE. You know how important it is for America to continue to invest in R&D and research so that we can maintain our leadership position in the world and build the clean energy economy. What recommendations do you have for us based upon your experience here 10 years after the failed, unfortunate Waxman-Markey bill? We are in a different place. This really is a climate emergency and we don't have time to waste. What do you recommend?

Ms. VANGENDEREN. I recommend that the Congress of the United States re-find its compass once again. As was noted by Congresswoman DeGette, and as I also stated earlier, there has been a lot of state and local action in the absence of Federal action. I would agree absolutely with Mayor Troxell that this is a partnership opportunity, that it absolutely has to be coordinated between the Federal, state, and local levels.

We, for example, are in the midst of helping to forge the transportation transformation in this region. This is a global issue that is going to have absolute implementation at a very local level. The

transformation in transportation is going to be a partnership between the city, the county, the private sector, and the university in this region that looks at strategically mapping where electric vehicle charging infrastructure ought to be placed, what are the sequential steps in the investment to further electrify, how much of the transportation sector should be electrified. If you are still plugging those electric vehicles into 52 percent coal power, we are not getting to our emissions goals.

So there are many, many parts to this puzzle, and I would really urge all of us to facilitate a more honest, open dialogue that can result in a good business plan to get us to sufficiently low carbon status.

Chairwoman CASTOR. Thank you.

Ranking Member Graves, you are recognized for 5 minutes.

Mr. GRAVES. Thank you.

Ms. Heidi—

[Laughter.]

Mr. GRAVES [continuing]. As chief sustainability officer, if tomorrow you were told you have to go to 100 percent renewables, can you give us just a few of the big obstacles that you see in being able to do that?

Ms. VANGENDEREN. First I would counter that, quite honestly, by saying we need to mine energy efficiency first and foremost.

Mr. GRAVES. Okay.

Ms. VANGENDEREN. Let's be strategic about what our sustainable energy plan looks like on this campus, in this community, and—

Mr. GRAVES. "Efficiency" meaning bringing down overall demand, therefore you can—

Ms. VANGENDEREN. The cheapest, least carbon-intensive energy is the energy you don't use at all, and we have not put that on the table sufficiently. It is a business opportunity, again, to expand that. We have a campus where there is a very old infrastructure. A lot of the buildings here were built—in fact, the first building was built before the State of Colorado became a state. So welcome to Old Main. Talk about a nightmare for my boss who oversees facilities. It is like, oh my gosh, what do you do with that? Many, many aspects of the energy economy.

In terms of renewables, there is the whole of the resilience consideration, so how much of the renewable energy future is going to be at utility scale versus a distributed scale. We are certainly looking strategically at how much we can produce on this campus but know that regionally there is going to be a broader play, again, to coordinate with our partners in the city, the county, and the private sector certainly, to get to a greater percentage of renewable energy.

We are looking at it. We are planning. We are trying to figure out what our next—right now we are looking at the 2.3 megawatts that we'll add to the roughly 2.2 we already have, and there are, as you know, many, many questions about how you keep the reliability of the system the more renewable-reliant it is.

Mr. GRAVES. Because the intermittent power and other things where the solar works when the sun is out, the wind works when the wind is blowing.

Ms. VANGENDEREN. Indeed.

Mr. GRAVES. I had a few other questions for folks, so if you wouldn't mind, I would love it if you could just give us something, nothing formal, any other thoughts you have on some of the obstacles that you have. You have kind of this microcosm, and it would be very interesting to hear some of your other thoughts along those lines.

Ms. VANGENDEREN. Be glad to.

Mr. GRAVES. To all panel members, look, I get it. Everyone is talking about we have to migrate to this 100 percent renewable, and folks saying that we need to stop producing fossil fuels. I want to throw out a few things. Number one, I was reading a report a while back that talked about how, for battery storage technology, it takes 50 to 100 pounds of mining rare and critical materials, oftentimes from China, to produce one pound of battery, one pound—50 to 100 pounds of mining, one pound of battery.

Number two, in 2011—and we had a chance to talk a little bit about this last night—in 2011 there was a moratorium on offshore energy production because of the Deepwater Horizon disaster that trashed much of our state. Don't get me started. But as a result, we significantly reduced domestic energy production. In 2011, the year after the BP disaster, one-half of this nation's trade deficit, one-half of the entire trade deficit, was attributable to us importing energy from other countries. We have had witness after witness come testify before our committees. So if we come in and say, hey, we are going to just stop producing, it doesn't stop demand because you have a system—I talked about the grid earlier, or the trucks or planes or what have you, that continue to be dependent upon these energy streams.

So we still have demand or dependence upon these streams. So if we are going to be dependent upon those, it seems like it makes more sense to produce it where we can do it safest and cleanest, and that is the United States.

Mr. Wright, do you want to expand on that? I think you also wanted to respond earlier to the question you received from Mr. Neguse.

Mr. WRIGHT. Yes, thank you. I will take both of those.

A real quick answer to your thing, it is best to have honest accounting. We have a much more black-and-white dialogue than really represents reality. There is 100 tons of coal inside every wind turbine tower, 100 tons in the tower; roughly another 100 tons used in the thermal process to get the coking coal into the tower. The blades are made, in meaningful part, out of oil and gas. They are mined in China, they are transported and assembled and monitored—it is impossible to have a wind farm without oil and gas, impossible.

So when we say zero emissions, we just have to do the full accounting. They are reduced emissions, but we should try to talk honestly about it.

And Representative Neguse's comments about VOCs, which are definitely health hazards, absolutely, but as oil and gas production has grown in Colorado, VOC emissions are going the other way. More modern wells are more dramatically reducing the emissions of VOCs such that total emissions from our sector, with four times the production, is 40 percent lower.

And we talked about one bad day, which was an inversion in Colorado, which is terrible, but we have those in Utah too, not from pollution in Utah. Pollution coming from out of our state into our state is a big issue, and we should account for and look at that as well.

But I am for clean air, clean energy, clean environment, the same things we want. I just wish we had a more honest, sober dialogue about it.

Mr. GRAVES. Thank you.

Madam Chair, just begging your pardon, three quick points. One, I just looked it up: 83 percent of VOCs come from non-oil and gas sources in Colorado.

Number two, one of the things, when we talk about these renewable energy jobs, I keep saying we have to get this right. Ninety percent—in fact, we talked about this at NREL yesterday. Over 90 percent of the solar panels are made in China. They stole our technology and are sending it back to us. So we have to think about how do we ensure that those jobs are anchored here, how do we do that differently than we have seen with those.

And lastly, under Waxman-Markey, if that had been enacted—let me put it this way. Through our emissions regime so far, we have actually reduced emissions greater than projected under Waxman-Markey with cheaper energy prices by doing it without Waxman-Markey, and it is an important thing to keep in mind. I think we can keep building on these successes.

Chairwoman CASTOR. But how much farther would we have gotten?

Mr. Casten, you are recognized for 5 minutes.

Mr. CASTEN. Thank you.

I have a number of questions for you, Mr. Weiner, really with a focus on rural America. In one of the presentations we heard at NREL yesterday, we looked at this map of where renewable resources are and, of course, where the load is, which gets into this conversation about transmission and storage, and those don't overlap real well, right? I mean, the solar is primarily in the southwest, geothermal is primarily in the northwest, wind is in a lot of places but primarily this big stripe down the middle of the country.

Biomass is kind of everywhere, but it is particularly concentrated in rural areas, and the sustainable portion of biomass is inseparable from wildfire risk. Forestry managers talk about wood on the forest floor as fuel. They don't mean fuel for a power plant. They mean fuel when it is a dry summer and a lightning strike comes along. But it is, of course, a source of generation fuel if we could access it. And as the only renewable source that is baseload and dispatchable, I think it is pretty important that we find some way to get it. And, by the way, their estimate was that that sustainable slice of biomass, we could make about 100 gigawatts. That is about the size of the whole U.S. nuke fleet, and it is about 10 percent of the U.S. grid. It is meaningful.

The challenge is that, as all of you know who have hiked in the forests around here, that wood on the forest floor is not necessarily near a road. It is on a steep slope, and it is really hard to get it out. But if we could get it, it is a fantastic job creation opportunity.

So I would just like your thoughts, with as much time as we have left, and I suspect we have some, what could we be doing federally to help ensure that we can cost-effectively and sustainably get that fuel out of a place where it is going to burn and just pollute the air into a place where we might use it as a source of renewable energy?

Mr. WEINER. Thank you. That is a great question, and I know that CSU has done some research on that. USDA did fund the Bioenergy Alliance Network of the Rockies project. This was maybe five years ago, a \$10 million grant I believe through USDA to help our researchers look into using fallen and dead biomass as a liquid biofuel. So that work is ongoing, and I think it is about to wrap up, so hopefully CSU has some recommendations for the Federal Government to offer.

I agree with your assessment of the challenges, and I suppose the one thing I would add is that I know the Forest Service, the state Forest Service in particular, is looking at opportunities to increase demand for biomass-based projects like boilers and wood heaters. So to your point earlier about supply and demand, I think if we see an uptick in demand and something like a state or a Federal Forest Service helping to facilitate that demand because of advantages financially or environmentally, then perhaps the supply can follow from that.

Mr. CASTEN. Briefly, one of the companies that I used to run was a bioenergy company out in California, and what we found was really hard was that the cost of getting that sustainable biomass out of the woods essentially scaled with the cost of diesel, because we had to bring chippers into the forest, diesel-fuelled chippers, run those, put it on trucks that could haul it out, and it makes a very narrow radius around where you can get it, and so as a result it is hard economically to go after. But in the meantime you still sit there and say leaving aside the self-interest of various businesses out there, you fly over and you see all that fuel waiting to catch.

So, much like the social cost of carbon, there is a societal benefit in getting it out of there and not indexing that to the cost of diesel, but I don't know that we have tools. So are there tools you have seen in place to help give people the right incentives to get that wood out of the forest?

Mr. WEINER. I personally can't speak to those tools. It is not an area that I have had a lot of experience in, other than to say there is a biomass plant in Colorado, in Gypsum, Colorado, on the West Slope that has made it work for them. So I am happy to find some resources for you and connect you with them.

Mr. CASTEN. Thank you.

Ms. VANGENDEREN. I would note, Representative Casten, that the fire hazard has changed that equation somewhat on what is viewed as necessary and economic in recovering some of that wood.

Mr. CASTEN. In what fashion?

Ms. VANGENDEREN. In that the fire hazard in the state is so great because of that woody biomass, the dead trees that you see along I-70, that the imperative has shifted a little bit in terms of what is economic.

Mr. CASTEN. So let's find some ways to get it out.

Ms. VANGENDEREN. Yes. And as Cary noted, the Danes will tell you it is best used for liquid fuel, not for generating electricity from an efficiency standpoint.

Mr. CASTEN. Okay, thank you.

I yield back.

Chairwoman CASTOR. Representative Neguse, you are recognized.

Mr. NEGUSE. Thank you, Madam Chair.

I do have a couple more questions for our mayors. But before I do that, I just want to address a prior point with respect to Mr. Wright's rebuttal, and that is I do think this is a conversation that should be sober-minded and focused on the data. So I will ask for unanimous consent to submit to the record a publication from the Journal of Geophysical Research: Atmospheres on "Source Characterization of Volatile Organic Compounds in the Colorado Northern Front Range Metropolitan Area During Spring and Summer 2015."

Chairwoman CASTOR. Without objection.

[The information follows:]

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**Submission for the Record  
Representative Joe Neguse  
Select Committee on the Climate Crisis  
August 1, 2019**

ATTACHMENT: Abeleira, A., I. B. Pollack, B. Sive, Y. Zhou, E. V. Fischer, and D. K. Farmer (2017), Source characterization of volatile organic compounds in the Colorado Northern Front Range Metropolitan Area during spring and summer 2015, *J. Geophys. Res. Atmos.*, 122, 3595–3613, doi:10.1002/2016JD026227.

The article is retained in the committee files and available at: <https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2016JD026227>.

Mr. NEGUSE. And just suffice it to say that I think it confirms the veracity of the statistics that I mentioned earlier.

I will also just quote from an article. This is two days ago. "Emissions from oil and gas wells account for about 12 percent of Colorado's total release of greenhouse gases, according to the state's best estimate, which it has acknowledged is flawed. The industry is the top producer of volatile organic compounds along the Front Range, a region that has failed to comply with Federal air quality standards for more than a decade."

That article cites—and this is one of the benefits of having a field hearing here in Boulder, is it cites the science, which is from a study that was published in July of 2017 by scientists at NCAR, which is, of course, here in Boulder which we were fortunate enough to visit just yesterday.

So with that, I would just again submit those into the record and proceed to my questions with the mayor.

[The information follows:]

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**Submission for the Record  
Representative Joe Neguse  
Select Committee on the Climate Crisis  
August 1, 2019**

ATTACHMENT: *Process-Based and Regional Source Impact Analysis for FRAPPÉ and DISCOVER-AQ 2014*. National Center for Atmospheric Research; Atmospheric Chemistry Observations and Modeling Laboratory, July 2017.

The report is retained in the committee files and available at: [https://www.colorado.gov/airquality/tech\\_doc\\_repository.aspx?action=open&file=FRAPPE-NCAR\\_Final\\_Report\\_July2017.pdf](https://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=FRAPPE-NCAR_Final_Report_July2017.pdf).

So, the question to the mayor of Boulder and the mayor of Fort Collins, you both mentioned in your written testimony and, I believe, Mayor Troxell, you mentioned it in your oral testimony, the work that is being done with the coalition of cities in Colorado, I wonder if you could expound upon that a little bit. It just is fascinating to me, and I suspect maybe to some of my colleagues on the committee, that cities are very diverse, very different, and I am curious as to how those interactions have gone and how you were able to build a coalition of cities that are perhaps politically different, obviously in very different ways, to come together around this common goal of bold climate action.

Ms. JONES. I will jump in there. We are proud to be one of the initial entities bringing this together, realizing that we all breathe the same air, we all like to ski in our mountains, and some of the entities that are participants are mountain communities that are very much dependent on a robust snow pack and not having it melt too quickly and things like that. So there is a lot to bring us together, and there was a recognition that working together across party lines, across geography, across sizes of towns, that we would get a lot more done at the state legislature, and that is certainly borne out.

So with the 28 cities and counties, it represents a sizeable portion of the population of Colorado, so suddenly we are getting a little bit more attention. But I will just note that there are a lot of commonalities, and we touched on some of them, which is that the impacts we are already feeling from climate are real, they are costly, they are dangerous to our citizens, and they affect both our quality of life and our economy, and that is the same regardless of whether you are Republican, Independent, or Democrat.

Mr. TROXELL. And I would add to that that there are a lot of similarities between the communities, and I think by coming together we can also share best practices. Although we might be neighboring communities, oftentimes we don't know exactly what is going on in each other's community. So being able to share those best practices and clearly the impacts, we can discuss those, but also what are the solutions and what are we doing, because a lot of it, at least from my perspective, is translating the challenges into real solutions at a local level, because it might be land use policies in terms of heating, or it might be transportation policies, or it might be other sorts of things that we can translate what is the challenge into what we can do at the local level.

Mr. NEGUSE. Thank you both again for your leadership. Thank you to each of the witnesses for their testimony. And knowing that we are getting closer to the conclusion of the hearing, I would just reiterate again my thanks to the Chairwoman and to my colleagues who traveled a great distance, Representative Graves and Representative Casten, for coming to Boulder.

With that, I yield back the balance of my time.

Chairwoman CASTOR. Thank you, Congressman Neguse.

Congresswoman DeGette, you are recognized for 5 minutes.

Ms. DEGETTE. Thank you so much, Madam Chair.

Mr. Wright, I heard you talking, and I do agree that some of these emissions, the CO<sub>2</sub>, the methane, if there is groundwater contamination, that doesn't just stop at state boundaries or municipal boundaries, and I think that is what I heard you say. Is that correct?

Mr. WRIGHT. That is correct.

Ms. DEGETTE. So therefore, in Colorado for example, the oil and gas industry, they comply with the Colorado rules around fracking and emissions; is that right?

Mr. WRIGHT. Yes.

Ms. DEGETTE. Would you agree with the governor and me and others that Colorado has one of the strictest methane rules of any place in the country? Is that right?

Mr. WRIGHT. That is right.

Ms. DEGETTE. And the industry in Colorado, to your knowledge, tries to comply with that methane rule; is that right?

Mr. WRIGHT. That is correct.

Ms. DEGETTE. And so wouldn't it seem to you that probably if we want to stop methane contamination all around the country, we should reinstate the Federal methane rule?

Mr. WRIGHT. As I talked about—

Ms. DEGETTE. A yes or no will work. [Laughter.]

Mr. WRIGHT. Not as currently—

Ms. DEGETTE. You don't think so, even though methane emissions from other states may come into Colorado's local government?

Mr. WRIGHT. There are right ways and wrong ways to do things. But, yes, reducing methane emissions is a positive thing to do. I will mention—

Ms. DEGETTE. But you don't think we should renew the Federal methane statute; is that right?

Mr. WRIGHT. In its current form, no.

Ms. DEGETTE. Okay, thank you.

Now, I wanted to ask you, Ms. VanGenderen, in your opening statement and in your written testimony you talked about a number of fabulous studies that are going on about ways to promote renewable energy and all kinds of carbon sequestration and electrification. How close are we to being able to enact those requirements, or how close are we to actually realizing that research and being able to bring it into our daily lives?

Ms. VANGENDEREN. It is dependent on the specific research underway. I think that it is also dependent on the devoted resources that are given to the realization of those. Again, we are working on the campus to make it a living, learning laboratory. Each breakthrough energy technology needs to be deployed in demonstrated fashion in order to prove its efficacy in the marketplace.

Ms. DEGETTE. So if you get the Federal funding that you need to support your research projects, will that help expedite the implementation?

Ms. VANGENDEREN. It could absolutely speed it up.

Ms. DEGETTE. Will some of this research actually help us as we try to move to a zero carbon emissions economy?

Ms. VANGENDEREN. There are some—if brought to scale, many of these could be game changers, absolutely.

Ms. DEGETTE. Thanks.

I want to follow up, actually, on something that Mr. Graves was talking about, because we have really seen in Colorado how having a commitment to shifting from fossil fuels has really worked. I would like to talk to our colleagues in Washington about this.

In Colorado, the legislature tried for some years to pass a renewable energy standard, and they were unable to do so because of the opposition of the utilities and the oil and gas industry. So finally, by voter initiative, in 2004, we passed the first renewable energy standard in the country by initiative, and it was 3 percent by 2007 and 10 percent by 2015. This was so wildly popular—the people in the audience know this—that the legislature has now increased the standard three times since 2004 with the support of the utilities and the industry. HB-1001 set a standard of 30 percent by 2020, still not enough, but I am going to guarantee you, with the commitment of our citizens and our businesses working together, that we are probably going to exceed that and we are going to have to go in and do more.

Xcel Energy, which is one of our big, big energy companies here, has made a commitment to zero carbon emissions by 2050, again not fast enough, not close enough, but this shows how fast this economy is moving, and it also shows that when you have a commitment by local governments and by a state to actually do something, and you can do it in a way that benefits the energy industry and that really benefits the constituents and the economy.

So that is why we can't just sit around in Congress and say, well, if we would have passed Waxman-Markey, then that wouldn't have been enough. We have to be bold, we have to be aggressive, and we have to have strong energy standards that are going to not only save our planet but also improve our economy.

[Applause.]

Ms. DEGETTE. So thanks again, Madam Chair. Thanks for having us.

Chairwoman CASTOR. I think that is a great statement to end on, but I want to thank everyone for attending today.

It is clear that Colorado is a leader, but we need your passion and your energy, your commitment, because we cannot do it alone, as I think was established here today. We can have all the terrific climate action here on the local and state level, but unless we have a bold Federal climate action plan, we are not going to be able to reduce carbon pollution, we are not going to be able to adapt as we need to adapt our communities. We are all in this together.

So I invite you all to follow the work of the committee, follow us on social media, be an engaged citizen, help us develop this climate action plan. It is only through working together that we will be able to develop the bold solutions that we need.

So at this time, I would like to advise the witnesses that you may get some follow-up questions. Please work as expeditiously as possible to relay your answers to the committee.

Thank you again to the University of Colorado-Boulder, and I will recognize the Ranking Member for a unanimous consent request.

Mr. GRAVES. Madam Chair, I ask unanimous consent to enter into the record a document developed by CIRES, UC-Boulder, titled

“Accounting for Ozone,” showing the ozone non-attainment since 2007 and some of the causes.

Chairwoman CASTOR. Without objection.  
[The information follows:]

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**Submission for the Record  
Representative Garret Graves  
Select Committee on the Climate Crisis  
August 1, 2019**

ATTACHMENT: McDuffie, E. E., et al. (2016), Influence of oil and gas emissions on summertime ozone in the Colorado Northern Front Range, *J. Geophys. Res. Atmos.*, 121, 8712–8729, doi:10.1002/2016JD025265.

The article is retained in the committee files and available at: <https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2016JD025265>.

A release and summary regarding the publication from CIRES is available at: <https://cires.colorado.edu/news/accounting-ozone>.

Chairwoman CASTOR. And without objection, all members have 10 business days within which to submit additional written questions for the witnesses. Please respond as promptly as you are able.

The hearing is adjourned. Thank you.

[Applause.]

[Whereupon, at 11:40 a.m., the committee was adjourned.]

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**United States House of Representatives  
Select Committee on the Climate Crisis**

**Hearing on August 1, 2019**

**“Colorado’s Roadmap for Clean Energy Action:  
Lessons from State and Local Leaders”**

**Questions for the Record**

**The Honorable Jared Polis  
Governor of Colorado**

THE HONORABLE KATHY CASTOR

- 1. In your testimony, you noted that Colorado has adopted Low Emission Vehicle standards and is considering adopting Zero Emission Vehicle standards. You also noted that Coloradans could save \$43 billion from a transition to electric vehicles by 2050. From your perspective as Governor, why is the proposal to rollback the Federal standards and slow automaker investments in new technologies a mistake?**

We Coloradans place a high value on our natural environment and the health of our communities. That is why as Governor, I have made protecting and improving air quality one of my top priorities. Achieving dramatic reductions of air pollution from the transportation sector will be critical to addressing this priority. Currently, transportation emissions are the largest contributor to unhealthy levels of ozone in the Denver metro area, and with the great strides that Colorado is making in transitioning to renewable forms of electric generation, transportation will soon be the largest source of greenhouse gas (GHG) emissions and will persist as the top GHG emitter for the foreseeable future.

To achieve the deep reductions in transportation emissions necessary to achieve our air quality and climate goals will require us to transition to lower emitting gasoline vehicles and ultimately zero emission vehicles. Accomplishing this transition won’t be easy. We currently have over five million registered vehicles in Colorado, and turning over this existing fleet to cleaner burning and zero emission vehicles will take time. But given the critical nature of the problem and the opportunity presented by a swift transition, we must pursue all reasonable strategies to accelerate this work.

Fortunately, there is a path forward. Thanks in large part to the new vehicle standards adopted by the Obama administration, automakers are well on their way to developing and implementing technologies that will achieve deep reductions in vehicle emissions. Every credible analysis that has been undertaken has shown that these standards will not only dramatically reduce emissions, they will also result in significant cost savings to consumers in the form of lower gasoline bills. Colorado's analysis shows that for model years 2022–2031, the Obama era standards will save Colorado consumers nearly 8 billion dollars, while eliminating over 31 million tons of greenhouse gas emissions to the atmosphere from Colorado vehicles. These standards, along with the revolutionary advances in electric vehicle technologies, and automakers commitments to producing and selling a rapidly expanding fleet of electric vehicles, means the future of a much cleaner vehicle fleet should look bright.

Unfortunately, the current administration in Washington not only refuses to lead us to this bright future, but is actively trying to undermine our progress. In seeking to roll-back technically feasible and cost-effective standards, the current administration is engaging in an unprecedented attack on our environment, our health and our pocketbooks. And it is doing so without any reasoned support. Analysis after analysis, along with the statements of the Environmental Protection Agency's own technical staff, have shown that the justification for the roll-back is based on unsupported and unrealistic factual assumptions, and analytical sleight-of-hand.

Further, in seeking to eliminate the rights of states to establish their own standards as expressly provided for under the Clean Air Act, the current administration is seeking to upend nearly a half century of precedent allowing states to go beyond the federal government in protecting their citizens from unhealthy air. Such an action demonstrates that the passionate pleas for protecting states' rights and preserving cooperative federalism that we so often hear from Washington are little more than empty slogans.

Finally, and almost unbelievably, this attack on our environment the health of our communities, our legal precedent, and reasoned decision-making, is being undertaken in the face of stiff opposition from the automakers themselves. This is an industry that relies on long lead times for developing its products, and as such regulatory certainty on applicable standards is absolutely essential. By seeking to roll-back these standards so late in the product development cycle, the current administration is creating regulatory chaos that severely undermines the ability of automakers to plan for and develop the next generation of vehicles.

We note that just this August the Colorado Air Quality Control Commission voted to adopt Zero Emission vehicle standards, pursuant to the authority granted by the Clean Air Act—and both the Alliance of Automobile Manufacturers and the Alliance of Global Automakers worked with the state on crafting the language proposed to the Commission, and supported adoption of the standard. The federal government should be seeking to foster and expand upon this type of cooperative effort between the states and the automobile industry to support advanced technology vehicles, reduce emissions and provide clear rules of the road allowing manufacturers to make long term investment decisions.

Ultimately, there is nothing positive about the current administration's attack on the current new vehicle standards. It's bad for the environment, bad for the health of our communities, bad for consumers, and bad for business.

**2. In your testimony, you mentioned that Colorado signed on to a Memorandum of Understanding with several other states in the Inter-mountain West on electric vehicle charging stations. Many of these states do not yet have targets to reduce greenhouse gas emissions. What are the anticipated economic benefits from building out corridors for electric vehicle charging?**

There are enormous economic benefits that come from a widespread transition to electric vehicles (EVs). These benefits included significant consumer savings on fuel costs, consumer savings on vehicle maintenance, and downward pressure on electric rates leading to consumer savings for all electric ratepayers. In addition, there are benefits associated with the public health benefits of reduced criteria emissions, as well as the benefits that come from reduced emissions of greenhouse gases.

In order to achieve these benefits, widespread adoption of electric vehicles is required. There are four key things that are necessary to achieve this—adequate charging infrastructure; availability of models that meet consumer needs; marketing to ensure consumers are aware of electric options; and financial incentives such as federal tax credits to address the up-front cost barriers during the early years of the market. The Regional Electric Vehicle agreement among 8 western states (AZ, CO, ID, MT, NM, NV, UT, WY), known as the REV West MOU, commits the states

to working together to address charging infrastructure along the interstate highways linking our states, thus addressing one of the key issues required in order to realize these benefits.

The State of Colorado has examined the net benefits associated with transportation electrification in some detail. Our analysis is based upon studies by the consulting firm MJ Bradley,<sup>1</sup> by the International Council for Clean Transportation,<sup>2</sup> and work done by the state Air Pollution Control Division in preparation for state adoption of a Zero Emission Vehicle standard.<sup>3</sup> The MJ Bradley Study examined the net economic benefits to vehicle owners (lifetime fuel savings minus cost differential for EV purchase), the monetized value of avoided carbon emissions, and the benefits to electricity ratepayers. This 2017 analysis found that under a moderate EV growth scenario, Colorado could experience a net present value of \$7.6 billion in cumulative net benefits by 2050. Under a high growth scenario, these could grow to more than \$43 billion.

One important issue to explain is why EVs provide a broad benefit to all utility ratepayers. The reason is that most EV charging takes place at night, during off-peak periods when the utilities have significant excess generation and transmission capacity. Adding off-peak load spreads fixed costs over a larger number of kilowatt-hours, which reduces the average cost per kilowatt-hour. The MJ Bradley reports concludes that each additional EV in Colorado generates a \$600 net benefit to utility customers.

In December 2018, a similar study was conducted in Arizona, which found \$31 billion NPV in net benefits by 2050 in a high EV adoption scenario.<sup>4</sup>

In addition to these quantified benefits, there are other important but harder to quantify benefits, including the creation of advanced vehicle technology jobs, the furtherance of EV tourism, and the extent to which having advanced technology and clean air can help to attract high quality employers and employees. I believe that Governors across the West, regardless of partisan affiliation, understand this broad range of benefits, and that is why we are all working together to enable widespread transportation electrification across the west.

**3. In your testimony, you mentioned that shifting to clean energy has helped created clean energy jobs in Colorado. Which Federal policies would help expand clean energy job opportunities across the United States?**

Bold climate action and a transition to a clean energy economy is not only a moral imperative, it's also a significant economic and job growth opportunity. As the U.S. Bureau of Labor Statistics reported earlier this year, solar installers and wind turbine service technicians are the two fastest growing occupations in the country.<sup>5</sup> A recent study conducted by Advanced Energy Economy, derived from data collected for the 2019 U.S. Energy and Employment Report, revealed that in Colorado clean energy jobs grew 4% last year, twice the rate of the state's overall jobs growth.<sup>6</sup>

While there is growing evidence that investing in the clean energy economy promotes significant job opportunities, federal and state employment statistics and other economic data could improve substantially and support enhanced policy development. In Colorado, we strive to ensure state policies are data driven and are continuing to improve data collection related to the clean energy economy. However, without federal investment in our labor market measures to keep pace with an evolving economy, we are left without sound data to fully illuminate the job impacts of policy in this area. Specifically, we would advocate for the Bureau of Labor Statistics to reinstitute tracking of "green jobs," including data on employment by industry and occupation for businesses that produce green goods and services; data on the occupations and wages of jobs related to green technologies and practices; and green career information publications.

Furthermore there is a need for increased investment in federally funded workforce programs. Over the past decade the states have seen significant cuts to the Workforce Investment Act and Workforce Innovation and Opportunity Act formula

<sup>1</sup>Plug-in Electric Vehicle Cost-Benefit Analysis: Colorado, MJ Bradley & Associates, April 2017.

<sup>2</sup>Electric Vehicle Costs and Consumer Benefits in Colorado in the 2020–2030 Time Frame, International Council on Clean Transportation, June 2018.

<sup>3</sup>Colorado Air Pollution Control Division, Final Economic Impact Analysis for Colorado Low Emission Automobile Regulation, pp. 20, 22. (Nov. 15, 2018).

<sup>4</sup>Plug-in Electric Vehicle Cost-Benefit Analysis: Arizona, MJ Bradley & Associates, December 2018.

<sup>5</sup><https://www.bls.gov/careeroutlook/2017/article/occupational-projections-charts.htm>.

<sup>6</sup><https://www.aee.net/articles/colorado-advanced-energy-jobs-exceed-those-in-hospitals-9-growth-expected>.

funds, Perkins Career and Technical Education and Adult Education funding. These cuts create challenges for states to fully harness the potential of the clean energy economy. These cuts have left businesses struggling to find skilled workers and left workers without pathways to better paying jobs. In Colorado, a recent survey revealed that 54% of employers find it very difficult to identify qualified candidates for advanced energy jobs.<sup>7</sup> Our rapidly changing economy requires investing in education and workforce programs now and in the future to realize the full potential of our clean energy future.

**4. In your testimony, you mentioned the just transition policies that were recently enacted by the Colorado legislature. What recommendations do you have for Federal policy that could accomplish the same goals?**

This past spring, I signed into law House Bill 19-1314: Just Transition from Coal-based Electrical Energy Economy.<sup>8</sup> This bill establishes a Just Transition Office tasked with aligning and delivering programming and funding to communities and workers impacted by a changing energy economy, in addition to disproportionately impacted communities who have borne the costs of pollution. Over the next year, an advisory committee will develop a draft Just Transition Plan for submission to the Governor and the General Assembly by December 31, 2020. The advisory committee is comprised of a diverse set of perspectives, ranging from impacted workers and communities, the private sector, legislative partners, economic and workforce experts, and government representatives. While it is premature to articulate specific Federal policy recommendations at this time, we have initiated an inclusive and proactive process to support and inform a just transition in Colorado. The Federal Government will no doubt be an integral partner in this work and we look forward to maintaining an open line of communication over the coming months.

**Questions for the Record**

**The Honorable Suzanne Jones  
Mayor of Boulder, CO**

THE HONORABLE KATHY CASTOR

**1. In your testimony, you mentioned that the City of Boulder and Boulder County have jointly launched initiatives focused on soil-based carbon sequestration. What Federal policies would help local governments carry out these types of initiatives?**

As mentioned in the Mayor's testimony, Boulder and Boulder County have launched a collaborative effort around soil sequestration. This partnership is aimed at experimenting with emerging strategies, such as innovative tillage, enhanced soil health practices and other regenerative agricultural techniques, to accelerate carbon drawdown and enhance local ecosystem productivity. When fully implemented, we believe these approaches could conservatively sequester 10% to 20% of local emissions. They also provide significant agricultural and ecosystem benefits such as increased resistance to drought and extreme weather events.

The city recommends the following federal policies to support local initiatives:

- Increase cost share funding to United States Department of Agriculture (USDA)-natural Resources Conservation Service (NRCS) to foster increased adoption of climate smart agricultural practices, e.g., reduced tillage, cover cropping, etc.
- Enhance crop insurance programs offered by USDA-Farm Service Agency (FSA) that create disincentives for cover cropping.
- Increase USDA-Agriculture Research Service (ARS) funding in Colorado toward soil-carbon sequestration research priorities fitted to high plains agroecosystems (irrigation, soil health principles and their economic implications).
- Support research and pilot projects in developing carbon credit marketplace for agriculture
- Increase funding for the NRCS Conservation Innovation Grants Program, which is one of the most important mechanisms to foster multi-party collaboration and innovation around emerging soil health and carbon drawdown strategies.
- Increase funding into National Institute of Farm and Agriculture (NIFA) sustainable agriculture and environmental resource and economic programs.

<sup>7</sup> <https://www.aee.net/articles/colorado-advanced-energy-jobs-exceed-those-in-hospitals-9-growth-expected>.

<sup>8</sup> <https://leg.colorado.gov/bills/hb19-1314>.

- Increase funding into Foundation for Food and Agriculture Research (FFAR) programs.
- Increase funding for Agricultural Extension Services.
- Reintroduce the Healthy Fields and Farm Economies Act.
- Amend the 45Q Tax Credit to include biochar and compost producers.
- Ask NRCS to work with ARS and private sector initiatives to standardize soil health protocols, as lack of standardization is causing a confusing set of non-comparable claims.
- Increase funding to USDA for soil health research and knowledge dissemination.
- Significantly increase funding to efforts that support young, veteran and socially disadvantaged farmers to gain access to land ownership and farm establishment support such as the Conservation Reserve Program-Transition Incentive Program (CRP-TIP).

**2. In your testimony, you explained that the City of Boulder's investments in residential energy efficiency leveraged almost ten times that amount in private investment. What Federal policies would help cities like Boulder continue to leverage private sector investments to reduce carbon emissions?**

*Electrification*

In cities across North America, fossil fuels that provides heating, cooling and hot water in buildings account for a significant portion of greenhouse gas (GHG) emissions—accounting for between 15% and 40% of emissions in a typical U.S. city. According to the Building Electrification Initiative (BEI), reaching “deep decarbonization” goals of 75% or greater reduction in greenhouse gas emissions will require eliminating most of the CO<sub>2</sub> produced by furnaces and water heaters across the country, alongside other measures across the economy.

In the long term, major utility investments and state regulatory action will be needed to fully transition buildings away from fossil fuels. In the short term though, city action can spark the development of new markets and equitable approaches for transitioning to high efficiency electric building systems. This action will deliver immediate GHG and air pollution reductions, while also providing information on best practices and laying the groundwork for more ambitious efforts that will be needed at all levels of government.

Given the scale, voluntary market development alone will probably not be sufficient to achieve these goals; it will require robust local, state, regional and federal policy regimes to transition away from fossil fuel-based building systems. Supporting market development activities will also be necessary to improve existing heat pump products, train and qualify contractors who can install them, and ensure there are customers who want heat pumps and understand their value.

In its 2018 report, *The Economics of Electrifying Buildings*<sup>1</sup> the Rocky Mountain Institute suggests that regulators, policymakers and utilities will need to make adjustments to energy efficiency programs and targets in order to accommodate beneficial electrification. Historically, most energy efficiency programs have focused on reducing electric energy consumption (in kWh) and natural gas energy consumption (in therms). Unfortunately, this approach risks providing a disincentive to beneficial fuel switching, either for buildings or transportation, if a utility will be penalized for adding kWh of electric consumption to the system.

The 2016 *Electricity Journal* article “Environmentally Beneficial Electrification: The Dawn of ‘Emissions Efficiency’”<sup>2</sup> suggests that energy efficiency targets should either be measured on a total energy basis—combining electricity, natural gas and other fuels—or on the basis of total emissions associated with the energy consumption. Otherwise, successful electrification could penalize utilities for not reducing electricity demand, even when it provides cost and carbon benefits. Additionally, policies that prohibit utilities from promoting fuel switching should be reevaluated to consider the benefits electrification could provide in meeting policy goals, including carbon reduction.

The Rocky Mountain Institute report further identifies the importance of removing “barriers to aggregated demand-side resource participation in wholesale market products, including energy, capacity and ancillary services.” These barriers include

<sup>1</sup> Rocky Mountain Institute, *The Economics of Electrifying Buildings*, based on data from the U.S. Environmental Protection Agency. <https://rmi.org/insight/the-economics-of-electrifying-buildings/>

<sup>2</sup> Dennis, Keith, Ken Colburn and Jim Lazar, “Environmentally Beneficial Electrification: The Dawn of ‘Emissions Efficiency,’” *The Electricity Journal*, Volume 29, Issue 6, July 2016, Pages 52–58, <https://www.sciencedirect.com/science/article/pii/S1040619016301075>

prohibitions on aggregated demand-side resource participation in some products and large minimum resource size requirements for individual loads or aggregations. The Federal Energy Regulatory Commission (FERC) is currently considering action to remove such barriers by requiring markets it regulates to allow aggregated resources to participate alongside traditional resources.

Finally, the Department of Energy and Environmental Protection Agency programs compare the performance of appliances to other models that use the same type of fuel. This approach diminishes the economic, environmental and grid benefits of switching from a fossil-fuel appliance to an electric one. States that follow these federal standards should be aware that the same-fuel-only comparison can reduce the ability to electrify. One solution is to update those standards to compare appliances across all fuel types.

#### *Federal Preemptions*

Federal policy currently prevents local jurisdictions from requiring installed appliances, such as heating and cooling equipment, to perform better than federal baselines. This requires jurisdictions to invest significantly in rebate and other incentive programs to drive more efficient choices by residents and businesses. Jurisdictions must be able to mandate better appliance efficiency through code, which would allow limited rebate dollars to be freed up to further leverage investment in deeper savings opportunities. This would also prevent 15- to 20-year stranded investments by residents and businesses in lower-performing equipment.

#### *Financing*

Efficiency and local energy generation are critical for reducing greenhouse gas emissions and for enabling a successful transition to a post-carbon future. However, particularly in states like Colorado where current energy costs are among the lowest in the country, the payback for efficiency and renewable investments is often too long (5 or more years) to motivate residents and businesses to make substantial investments. This ultimately has the impact of tying up cash reserves or creating longer-term personal financial obligations. Options that allow efficiency and renewable improvements to be made with lower financial obligation and that allows the obligation to transfer with the property at time of sale would greatly accelerate efficiency and renewable adoption. Examples of mechanisms include property assessed clean energy (PACE) where low-to-no interest loans can be spread over 20 years of property taxes. Similarly, tariff-based financing, where utilities front the cost of the investment and recover that investment through utility rates would help drive adoption.

### **3. You mentioned that the Colorado Communities for Climate Action supports expanding the focus of the Natural Resources Conservation Service to include regional-scale land management to improve resilience to climate impacts. Could you please describe this recommendation in more detail?**

*PLEASE NOTE: The following recommendations originate from the City of Boulder rather than the Colorado Communities for Climate Action*

Recent reports from the IPCC and other sources confirm that significant impacts from climate change are now inescapable in the next 10 to 30 years. According to a recent Union of Concerns Scientists analysis, these changes will result in dramatic impacts across the US<sup>3</sup> including:

- The average number of days per year with a heat index above 100°F will more than double, while the number of days per year above 105°F will quadruple
- More than one-third of the area of the United States will experience heat conditions once per year, on average, that are so extreme they exceed the current NWS heat index range (above 137°F)
- Nearly one-third of the nation's 481 urban areas with a population of 50,000 people or more will experience an average of 30 or more days per year with a heat index above 105°F, a rise from just three cities historically (El Centro and Indio, California and Yuma, Arizona).

These findings underscore the critical importance of significantly expanding research and technical assistance for cities to address the way these conditions will be mitigated or aggravated by urban development and urban landscape management.

Less recognized is the interrelationship between urban heat impacts and the management practices in landscapes which surround cities. There is growing evidence

<sup>3</sup> <https://www.ucsusa.org/sites/default/files/attach/2019/07/killer-heat-analysis-full-report.pdf>.

that factors like soil moisture levels in areas surrounding cities dramatically impact the incidence and intensity of urban heat extreme events.<sup>4</sup>

Additional funding and pilot project development is needed to explore strategies for utilizing land conservation and management policies to shape climate extreme resilience in both rural and urban communities. The NRCS provides a logical platform for managing resources directed to this purpose. The NRCS platform grew out of the original Soil Conservation Service established in 1935 at the height of the Dust Bowl. It has a history of conducting landscape scale assessment and conservation strategy development to address large scale environmental and social challenges.

In more stable and prosperous times, NRCS's work focuses more on parcel-level technical assistance and incentives; however, in eras of disruptive change, NRCS has been on the forefront of landscape-scale strategy and action. In the 1930s, this included deploying hundreds of thousands of workers implementing soil conservation actions like erosion control or planting windbreaks. In the farm crisis of the 1980s, NRCS was able to launch the Conservation Reserve Program which created connected networks of conservation areas across broad areas of the Plains states.

Congress should empower and resource the NRCS to explore how it can use both its existing tools and programs and new management systems to develop landscape-scale assessments. These assessment would identify how to enhance the capacity of landscapes to drawdown significant volumes of carbon, increase water holding and infiltration capacities, provide enhanced regional cooling services to metropolitan areas and increase the fertility and productivity of lands that are now significantly degraded due to climate change and past management practices. This would start with a comprehensive soil assessment using standardized soil inventory procedures (see previous recommendations on soil health for more detail). The work identified through these assessments would then form the foundation for exploring Green New Deal-scale reinvestment strategies that could provide employment opportunities for a large-scale workforce.

#### Questions for the Record

**The Honorable Wade Troxell  
Mayor of Fort Collins, CO**

THE HONORABLE KATHY CASTOR

**1. In your testimony, you referenced the Bus Rapid Transit system in Fort Collins. What Federal policies would help expand Bus Rapid Transit systems in cities like Fort Collins?**

The primary consideration when implementing MAX Bus Rapid Transit centered around funding. The Federal Transit Administration Section 5309 Capital Investment Grant funding for Small Starts funded the MAX Bus Rapid Transit project. Small Starts is a result of the publication of the Major Capital Investment Projects Final Rule in January 2013 (49 CFR Part 611). Through the MAX Bus Rapid Transit project, the City of Fort Collins hired consultants to assist in navigating the complex regulatory process required for a project of this size.

Moving forward, the following policies and considerations could assist scaling Bus Rapid Transit in communities like Fort Collins:

- A combination of increased funding dedicated to planning and design, continued support of the Small Starts program or similar, and continued backing for funding to maintain infrastructure and ongoing operations into the future, and
- Review of current federal policies to determine where existing requirements can be streamlined to reduce the regulatory and application burden for communities.

**2. You mentioned that the City of Fort Collins received an award for its work to expand the benefits of energy efficiency to low- and moderate-income renters by promoting energy efficiency in rental homes. Are there Federal policies that would expand the ability of cities like Fort Collins to develop and implement such programs?**

In Fort Collins' testimony, we referenced our recent \$1M award from Bloomberg Philanthropies to launch the Epic Homes program, which targets renter-occupied

<sup>4</sup> <https://www.climatechangepost.com/news/2019/2/18/when-soil-dries-out-europes-heat-waves-will-become/>.

homes for efficiency upgrades. One of Bloomberg's goal with each of these awards is to fund projects that create replicable, scalable products and solutions.

In that process, we found one key barrier to implementing efficiency projects in rental homes, benefiting low- and moderate-income residents, is the availability of low-cost long-term capital. The success of the federal program Rural Energy Savings Program (RESP) could be replicated for non-rural communities such as Fort Collins. Senator Merkley (OR) has proposed a Community Energy Savings Program with input and experience from Fort Collins on-bill financing efforts. The ability to access low or no interest long-term capital expands the opportunity for efficiency to many more homes and could be replicated across the country.

In addition, the federal government could extend the 2017 Renewable Energy Tax Credit to include residential (non-commercial) rental properties. Currently principal residences and 2nd homes are eligible, residential rental properties are not.<sup>1</sup>

**3. In your testimony, you mentioned that systems-thinking and grid integration must be an important part of any clean energy strategy. How should Federal policies incorporate these considerations?**

The ability to integrate electric grid elements from generation and transmission to distribution systems and customer facilities generally requires transparent market mechanisms. Federal policies which support the establishment and operation of electricity markets would also support enhanced systems-thinking and grid integration. The Department of Energy has led effort to modernize electricity systems, e.g., through their Smart Grid Investment Program, and these types of national investments will be critical to achieving a national clean energy system.

In addition, energy storage is critical to a clean energy strategy and supports community and national resilience. FEMA is increasingly funding implementation of preparedness planning as part of All Hazard Mitigation Plans (not just disaster response funding), which include energy storage and grid resilience strategies.

**Questions for the Record**

**Cary Weiner  
State Energy Specialist, CSU Extension  
Director, CSU Rural Energy Center  
Colorado State University**

THE HONORABLE KATHY CASTOR

**1. In your testimony, you mentioned that the Rural Energy for America Program and the Rural Energy Savings Program should be updated and revised. Could you please describe in more detail how these programs could be improved?**

The Rural Energy for America Program (REAP) has incentivized energy improvements across the country by offering grant funding for projects, energy audits, and renewable energy development assistance. Colorado State University Extension has been the recipient of two REAP grants in the last five years that have allowed us to provide renewable energy development assistance to farmers in Colorado. Specifically, we have conducted economic feasibility assessments for solar and wind energy at 60 farms across the state. These assessments provide detailed estimates of the financial costs and benefits of installing solar or wind on-farm, including a 20-year cash flow, identification of potential tax implications, and phone calls to discuss results.

I believe that interest has been high in our assessments for a number of reasons such as falling solar prices, tax credits that will decrease in coming years, and perceived cost savings from solar energy when compared to utility electricity. I also believe that the free cost to participate has played a significant role in attracting farmers to the assessment program. Because energy efficiency often offers a quicker return-on-investment than renewable energy, we have considered expanding our offerings from just renewable energy development assistance to include energy audits through REAP. But we have decided not to apply for a REAP grant to conduct energy audits because participating agricultural producers and small businesses would be responsible for a 25% cost share.

Although it seems reasonable to ask for producers and business to contribute to the cost of audits, I believe that the cost share requirement may actually prohibit these entities from participating. If we were to charge \$1,000 for an audit to recoup

<sup>1</sup> [https://www.energystar.gov/about/federal\\_tax\\_credits/2017\\_renewable\\_energy\\_tax\\_credits](https://www.energystar.gov/about/federal_tax_credits/2017_renewable_energy_tax_credits).

costs from travel and staff time, for example, a 25% cost share would mean that a farm or rural small business would have to pay \$250. But because few small businesses rural Colorado have received and acted upon energy audits, it is difficult to convince them that a \$250 investment is worthwhile. A simple change to the REAP energy audit program eliminating or reducing the 25% cost share requirement could result in demonstrations of the effectiveness of energy audits as effective tools in managing energy costs. Once audits become more established as valuable tools in areas where they are currently not mainstream, perhaps the federal government could reinstate a 25% cost share.

In addition, of the 60 economic feasibility assessments we conducted for on-farm renewable energy, four went on to apply for REAP grants to install projects on their farms. Of these four applicants, only two were successful. Although the economic feasibility of the two farms that were rejected was comparable or better than the two successful recipients, they were not funded. And like with energy audits in some parts of rural Colorado, renewable energy projects on-farm are still in need of demonstration and successful case studies. Expanded REAP funding for on-farm renewable energy projects in particular would allow for more projects to be installed and more case studies to be established, which in turn will increase interest and further the goal of the program.

As far as the Rural Energy Savings Program (RESP), the program can have tremendous benefits for rural energy users. Rural electric cooperatives can borrow funds from USDA's Rural Utilities Service at 0% interest for re-lending to cooperative members for energy improvements. Some utilities can use this program to start on-bill financing programs for members, which can make energy improvements more financially attainable and seamless than other options such as borrowing from another lender.

My suggestion regarding RESP comes from discussions with two rural electric cooperatives who have participated in the program. In both cases, the utilities pointed out that while reasonable precautions were taken by USDA around the application process, once the applications were approved there is a very significant time lag before funds are received by the utilities (as borrowers). In the case of Highline Electric Association, for example, there was a two year period between when they were approved into RESP and when they could access the funds (1). Looking into ways to expedite access to funds for approved RESP participants would both make funds available for energy projects in a more streamlined manner and also incentivize participation from more utilities that perhaps are put off by the current lengthy process.

**2. You also suggested that the USDA-USDOE State Extension Energy Partnership Program should be restarted. Could you please describe this pilot program, its successes, and your recommendations for how this program should be implemented if it were to be restarted?**

The State Energy Extension Partnership (SEEP) program was developed based on a Memorandum of Understanding (MOU) between the US Department of Energy (DOE) and the US Department of Agriculture's (USDA) National Institute of Food and Agriculture. This effort was a project of the State Energy Advisory Board, which was established by the State Energy Efficiency Programs Improvement Act of 1990 to advise DOE on the operation of its federal grant and clean energy programs (2). The explicit purpose of SEEP was, ". . . to identify issues, develop solutions, and share promising practices collaboratively across organizational, geographic, and programmatic boundaries to promote energy efficiency and renewable energy." This partnership funded an initial cohort of State Energy Office and Extension collaborations in Wisconsin, Nebraska, and Kentucky with DOE awards of ~\$200,000-\$250,000 over a three-year period from 2012-2015 (3).

The Wisconsin SEEP program formalized the collaboration between Wisconsin's State Energy Office and UW-Madison Extension with an MOU to better integrate their roles in helping create transformational change toward a clean energy economy in the state. UW Extension engaged local governments, tribes, businesses, farms, and county-based Extension educators in energy efficiency, renewable energy, and bio-energy education and projects. By training Extension agents and supporting community leaders, the partnership between UW Extension and the Wisconsin Energy Office built capacity for energy education and community planning as well as a formal structure for collaboration on energy issues which continues today (4).

SEEP programs in Nebraska and Kentucky also increased the capacity of Extension to have local impact and forged meaningful partnerships with State Energy Offices. In addition to engaging over 2,000 farmers and crop consultants on irrigation energy efficiency, Nebraska Extension drafted a strategic cooperation document for future cooperation between UNL and the Nebraska Energy Office (5). In Kentucky,

an Energy Efficiency Awareness and Action program expanded the capacity of Extension agents to engage in energy work, including helping residents and businesses better manage their energy bills and helping 4-H youth make their households more energy efficient (6).

If a SEEP program was to be restarted, it should focus on the unique strengths of State Energy Offices and Extension to build capacity for community-driven energy solutions. Both State Energy Offices and state Extension energy programs vary widely in size, scope, and focus. But in general, State Energy Offices excel at prioritizing energy issues of importance to state leaders and providing funds to implement priority projects. State Extension energy programs tend to focus on empowering residents, businesses, agricultural producers, and community leaders to address sustainable energy issues through planning, education, and technical assistance. Working together, State Energy Offices and state Extension energy programs can engage stakeholders in collaborative energy initiatives and provide funding for implementation of those initiatives. This work is critical to help communities of all kinds reduce greenhouse gas emissions in ways that respect unique local situations.

Both past SEEP pilot projects and existing Extension programs have provided a solid foundation from which to grow this community-based, collaborative approach. The University of Minnesota Extension's Clean Energy Resource Teams have conducted energy planning and implementation with local governments throughout the state. Colorado State University Extension has conducted numerous community energy assessments that identify and help acquire funding and technical assistance for local governments based on broad stakeholder input and community needs. A renewed SEEP program could build lasting relationships between State Energy Offices and Extension in order to broaden and deepen the impact of community-based collaborative energy planning and implementation across the country. Leveraging Extension's background to focusing on collaborative community energy planning and implementation in rural America could be an especially effective strategy for SEEP.

I would also make two more technical suggestions for a future SEEP program. First, it is my understanding that funds for the three pilot projects came from DOE. It may be worth revisiting the MOU between DOE and USDA to see how each agency might contribute more equally to future projects. Second, State Energy Offices were the only eligible primary applicant in the first SEEP Request for Proposals. I would recommend that either State Energy Offices or Extension programs could be listed as the primary eligible applicant in future SEEP RFPs.

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### Questions for the Record

**Heidi VanGenderen**  
**Chief Sustainability Officer**  
**University of Colorado-Boulder**

THE HONORABLE KATHY CASTOR

- 1. In your testimony, you mentioned that public-private partnerships are needed to gather the capital required to facilitate a transition to clean energy. What types of partnerships with the public and private sector would help universities like yours achieve their climate and clean energy goals? What Federal policies could help facilitate these partnerships?**<sup>1</sup>

There remain a large number of technologies requiring discovery and development to fully realize clean energy goals. These are not only in clean energy generation, but also in transmission, storage, distribution, usage, monitoring, etc. Additionally, these needed technologies span numerous disciplines. While the private sector has commercial interest in the clean energy economy, industry's ability to fund this necessary technology development is insufficient for all that is needed to realize the clean energy future. The public sector can support development of these technologies by encouraging and funding partnerships where government, industry, and academia come together to investigate and solve the hard problems and help these technologies "cross the chasm" from lab to commercialization. Additionally, the Federal Government could support these partnerships by driving a system-level approach for all of the technologies and systems that will be required to realize the clean energy future. Silo'd development will result in incremental change, but revolutionary change requires system-level requirements, development, and interoperability. Individual technologies can be powerful, but engaging all of the required disciplines together in these partnerships will drive realization of these goals more quickly.

The October 2018 IPCC report that focused, in part, on the investment required to keep warming under 1.5 degrees C noted that the transformation to a world powered almost entirely by clean energy will require a global investment in clean energy and infrastructure of \$1.6 trillion to \$3.8 trillion a year (in 2010 U.S. dollars) with an average of about \$3 to \$3.5 trillion per year from 2016 to 2050. (This is compared to an estimated \$2.4 trillion a year that would otherwise be invested in energy systems).

Unleashing private sector capital in this investment need is vital to achieve sufficient scale. However, the private investors have learned over the past decade that investment in clean energy will not be simple given technological, economic, and political uncertainties. Public-private partnerships are one strategy that, when designed well, can attract greater net investment, unlock new management expertise and efficiencies, and, importantly can help strike the balance between protection of the public interest and generating strong return on investment (for both the public and private partners). Public policy and endorsement of emerging clean energy technology can drastically reduce the uncertainty of private investment. We witnessed this in Colorado through multiple city and state-level endorsements of the emerging wind and solar industries.

Universities are distinctly positioned to provide a platform for innovation and to serve as a test bed of both individual technology demonstration, and more broadly, through the integration of new and existing technologies at a systems level. The resources that exist to do either or both of these rarely, if ever, exists within a university alone. Universities can effectively collaborate with the municipalities in which they are embedded to demonstrate the feasibility and scalability of clean energy and energy efficiency solutions. Further, universities are often the source of innovations that need the support of both local and federal policy in order to gain access to funding. A cross-fertilization between private sector and university partners toward research (theoretical and applied), financial capacity, implementation capacity, and data tracking and analytics between the private sector and university partners can help facilitate the required array of assets to achieve adequate clean energy and climate goals. Because universities often house faculty studying the economic, policy, and technological impediments, and inducements, to clean energy adoption, they can

<sup>1</sup>My responses to these QFRs represent views stemming from my professional background in energy and sustainability policy, and do not represent the official positions of the University of Colorado Boulder.

provide a natural facilitation role between early stage technology, public entities, and private investors.

Many, such as the National Conference on State Legislatures, have noted that policies governing Public Private Partnerships (P3's) should remain largely at the state level, with the federal government providing overarching guidance. The federal government, however, importantly, can forge policies that will result in expanded funding for the development of technologies, its deployment and financing of low carbon strategies. A federal tax on carbon emissions, or the reduction of subsidies for fossil fuel production are two of the simplest potential policies that would fuel innovation and adoption in clean energy. Recent research has shown that both federal regulation of coal-fired emissions, and policies encouraging adoption of clean energy have had a significant impact on accelerated coal-fired electricity unit retirements. There are a number of current bills before Congress that address strategies to expand the "seed" and partnership capital that could be devoted to effective public/private/university partnerships working to achieve a sufficiently low-carbon economy. Federal endorsement can change the economic calculus of private investment through not only tax incentives, but also through creating a sense of support for new, cleaner energy technologies, sowing the seeds from more localized state, county, and city-level P3s.

Well-structured, transparent, and focused partnerships between universities, the public sector and the private sector are imperative if we are to achieve our climate and energy goals. In the university world, expanded funding for research, and demonstration of that research on the university campuses and in the communities in which those universities reside is a critical element. Our ability to harness emerging research into economically sustainable industries is critical not only to addressing climate change, but to our nation's economic future.

**2. You referenced some examples of innovative new technologies developed by CU Boulder researchers that could improve monitoring of CO<sub>2</sub> emissions and create opportunities to re-use CO<sub>2</sub>. How should Federal R&D investments be expanded to maximize these opportunities?**

Federal R&D investments shape the research landscape. To fully leverage the game-changing tools and methods that can emerge from university labs, the government can consider:

- Additional investment in ARPA-E and DARPA-style funding for high risk/high reward projects in clean energy, resilience, and decarbonization. For instance, an ARPA-E grant funded a team of researchers from CU Boulder, CIRCES, NOAA, and NIST to adapt Nobel Prize-winning laser technology developed at CU Boulder into an inexpensive, portable, robust instrument that can detect methane and other gas leaks from oil and gas operations as they occur, allowing operators to catch and control leaks. A startup company is now commercializing the technology. (<https://cires.colorado.edu/news/detecting-methane-miles-away>)
- Robust funding of NSF, NASA, NOAA, DOE, and other federal funding sources that invest in R&D, paired with a recognition that multidisciplinary research can often yield the most innovative results. Federally funded research is transforming every aspect of the energy landscape, including emissions detection, carbon and methane capture, reuse of carbon in fuels and building materials, battery storage, grid optimization, and many others. For example, CU Boulder researchers have developed nanobio-hybrid organisms that capture CO<sub>2</sub> and nitrogen from the air to produce fuels and plastics (<https://www.colorado.edu/today/2019/06/11/these-nano-bugs-eat-co2-and-make-eco-friendly-fuel>). Another CU Boulder team developed an innovative wastewater treatment process called Microbial Electrolytic Carbon Capture (MECC), which purifies water in a way that absorbs more CO<sub>2</sub> than it releases while creating renewable energy, all in a potentially lower-carbon, lower-cost way than that provided by existing carbon capture technology (<https://www.colorado.edu/today/2015/08/03/cu-boulder-researchers-use-wastewater-treatment-capture-co2-emissions-and-produce-energy>). Adequate funding—in a stable funding environment—can maximize the potential of this type of research.
- Secure, sustainable funding for baseline monitoring projects in federal agencies on which our university research often depends. For example, CU Boulder laboratories are part of the Global Greenhouse Gas Reference Network within the NOAA framework (<https://www.esrl.noaa.gov/gmd/ccgg/index.html>). The program collects air samples from locations around the world to measure the distribution and trends of the three main long-term drivers of climate change (carbon dioxide, methane, and nitrous oxide) and carbon monoxide that is an indicator of air pollution. Samples are regular, not random; and that steady collection of data is what makes these long term records of Earth's atmospheric composition so fundamentally important. It provides critical diagnostic information on sources and sinks of greenhouse gases. It is

already becoming a valuable tool to validate carbon emission targets across continental and national boundaries, which may play an important role for enforcement of agreements. (For example: <https://news.agu.org/press-release/new-monitoring-system-identifies-carbon-dioxide-from-fossil-fuel-burning/>) Many of our federally funded scientists conduct innovative research on emissions detection, monitoring, and modeling based on this ground truthed data. Yet, many years of flat or decreased funding have translated to significant virtual cuts, as rents and operational costs continue to rise unmatched by funding. Similar Congressional cuts have been made to virtually every baseline monitoring project in the environmental sciences.

By setting a priority on funding decarbonization, resiliency, and clean energy efforts, expanded Federal R&D investments can unlock the discoveries and innovation that can help move us forward to a clean, resilient future.

