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HEARING ON THE FISCAL YEAR 2022 PROPOSED BUDGET FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED SEVENTEENTH CONGRESS

FIRST SESSION

APRIL 28, 2021

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COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED SEVENTEENTH CONGRESS

FIRST SESSION

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C O N T E N T S

HEARING ON THE FISCAL YEAR 2022 PROPOSED BUDGET FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY

WEDNESDAY, APRIL 28, 2021

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The Committee, met, pursuant to notice, at 10:04 a.m. in room 301, Dirksen Senate Office Building, Hon. Thomas R. Carper (Chairman of the Committee) presiding.

Present: Senators Carper, Capito, Cardin, Whitehouse, Markey, Duckworth, Stabenow, Kelly, Padilla, Inhofe, Boozman, Wicker, Sullivan, and Ernst.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Good morning, everyone. I call the Committee to order.

We are pleased to welcome back before us our Administrator Michael Regan before our Committee as we prepare to discuss President Biden's Fiscal Year 2022 Fiscal Proposal for the Environmental Protection Agency.

Welcome. It is great to see you. Thank you for joining us earlier today on another call.

It has been some time since this Committee has held a hearing on the EPA budget. I want to thank Administrator Regan for returning before us so soon after his confirmation a little over a month ago.

I also want to acknowledge that a leader is only as good as the team around him or her, and I am very pleased and grateful with this Committee's work to confirm Janet McCabe on the floor yesterday by 52-44 vote as Deputy Administrator at EPA.

While not everyone our Committee voted for confirmation, I really do appreciate the spirit of goodwill that everyone has demonstrated. The Administrator just talked to me again about his interactions with some of the members of this Committee, how much he appreciated those. I think it bodes well for the work we have ahead of us to ensure cleaner air, cleaner water, and a better future for the American people.

With that, let me get started. It is oftentimes said that budgets are about priorities. While President Biden has only released a bare bones budget to date, it is clear that the Administration's priorities are aligned, at least in my view, with the needs of the Amer-

ican people. The budget focuses on protecting public health, supporting our Nation's economic recovery, and addressing the greatest threat that we face, and that is the climate crisis.

Over the last decade, EPA simply hasn't been provided with the resources it needs to get the job done. The agency has been largely flat funded almost for a decade, a funding commitment that has undermined EPA's mission.

Over the last 4 years, we have seen unfortunate Administration proposals to slash the agency's budget by 30 percent—30 percent. That would have made EPA's ability to respond to a host of environmental challenges facing us even more daunting.

That is why I am pleased that President Biden's proposed fiscal year 2022 budget would largely restore the agency's degraded capacity by increasing its budget by roughly 20 percent. This restorative budget is necessary for EPA to have a fighting chance to ensure the hopes and expectations of a President and Congress 50 years ago are realized today.

At no time in recent memory has the need for investment in American health been more urgent than today, as we emerge from the worst pandemic in 100 years. As we know, over the past year, the coronavirus has taken over a half-million lives and has been especially deadly for many communities of color, low income communities and rural communities throughout our country. These are the communities that have been most assaulted by pollution over the years.

As co-founder of the Senate Environmental Justice Caucus along with Senators Duckworth and Booker, I am gratified to see that this budget focuses on protecting the needs of these communities, something that I know you, Administrator Regan, have prioritized at EPA.

I am also encouraged to see the Administration treat the ever growing threat of the climate crisis with the urgency that it deserves. If we are going to successfully cut greenhouse gas emissions in half by the end of this decade while creating millions of new jobs, we need a strong EPA that uses science as its north star and has the resources that it needs to effectively seize this opportunity.

As we shift toward the clean energy solutions of the future, we must make smart, new investments in infrastructure and work force development to support these efforts. The President's budget reflects the vision of this Nation that we can look to for inspiration as we work together to deliver on the promises of cleaner air, cleaner water in every zip code and create good paying American jobs to position our economy well into the future. In this Congress, EPA is already hard at work to realize that vision.

Senator Capito and I, with a whole lot of input from our colleagues throughout the Senate, are drafting a Surface Transportation Reauthorization bill, and we have bipartisan water legislation currently before the full Senate, I think tomorrow. We are looking forward to a debate and hopefully a strong passage of that bill with a bipartisan vote.

That spirit of bipartisanship is at the core of EPA's story, whether the Chair was Jim Inhofe, or Barbara Boxer, or John Barrasso, or me. It is in our DNA, and we want to keep that routine as long as we can.

Coincidentally, when the EPA was created over 50 years ago, our country was facing enormous challenges due to dangerous levels of air and water pollution. In 1965, a study by the New York City Council found that breathing New York's air had the same effect as smoking two packs of cigarettes a day. Think about that, two packs of cigarettes, just by breathing the air in New York City.

In response, spurred by life threatening air pollution, not just in New York City, but all over the country, a burning Cuyahoga River in Cleveland, just north of where I went to college, and a host of horror stories borne of rampant emissions and discharges across the landscape, President Richard Nixon—imagine that, President Richard Nixon— established EPA with the affirmation of both Republicans and Democrats in Congress. They tasked this new agency with protecting our air, protecting our water, and protecting our health.

Since that time, we have made tremendous progress in improving our Nation's air quality, providing safer drinking water, cleaning up hazardous waste sites and protecting against harmful chemicals. Today we face perhaps even greater challenges, a deadly pandemic, the worst economy since the Great Depression, and the urgent crisis of climate change.

On top of all that, another challenge persists at EPA, that is, how do we build agency morale after years of undermining it. To EPA's career employees, who have persevered through this turmoil, our Nation owes you a heartfelt thank you.

I will conclude by saying this. The challenges before us are great. But as my colleagues and Administrator Regan oftentimes hear me quote Albert Einstein, in adversity lies opportunity. Lots of adversity, but also plenty of opportunity.

We have Joe Biden as our President, our old colleague as our President, and Michael Regan as EPA Administrator, two people who I believe are uniters, not dividers. Now we have an opportunity to come together to face the crises before us, united in common purpose.

With new and capable leadership, strengthened by a restorative budget proposal, EPA and the rest of us face brighter days ahead, especially if we continue to make more progress on vaccination, on vaccinating Americans.

Michael, we look forward to hearing from you about how you plan to bring us to that brighter future.

With that, I want to turn first to our Ranking Member, Senator Capito, for any remarks that she might like to make.

Welcome, and thank you, Senator Capito.

OPENING STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator CAPITO. Thank you, Chairman Carper, and thank you for having today's hearing on the EPA's budget proposal for the upcoming fiscal year.

Administrator Regan, welcome back to the Committee. Congratulations on your confirmation. I think this is the first chance I have had to tell you that in person. I greatly appreciated your commitment throughout the nomination process to regular and trans-

parent communication with Congress, and your presence here today is a testament to that commitment. So, thank you.

I look forward to hearing more about the President's budget proposal and your vision for the EPA. We all want a Government that serves the American people and is receptive to their needs. While we work together to develop bipartisan legislation and policies through regular order, we increase our chances of achieving that goal.

I want to thank Chairman Carper for following that approach to developing a drinking water and wastewater infrastructure bill that is on the floor this week. We are all excited about that in this Committee, aren't we? Yes.

Administrator Regan, I thank you and your team for their technical assistance to our Committee staff in developing this bill. It has been absolutely critical. We look forward to pushing for its enactment into law and eventual implementation by EPA.

I also want to thank the Administration for pushing forward with the publication of the regulatory determination for PFAS and PFOA, you and I have talked about this many times, under the Safe Drinking Water Act following my letter that I wrote to Chief of Staff Ron Klain. Setting drinking water standards that follow the regulatory process is another example of an area where there is bipartisan agreement.

I look forward to hearing more from you during this hearing about the status of the agency's activities under the PFAS action plan that was released in 2019.

An area where I have real concerns, however, is the direction that the agency is taking, and the Administration is taking, with climate. I do not believe a bipartisan approach to climate regulation is being followed by the EPA so far. I hope that you can change that. The Biden administration has rolled out historic numbers of new climate actions by executive order.

Last week, the Administration unveiled a new U.S. nationally determined contribution under the non-binding Paris Agreement. The Administration promises to meet that new target through new regulations. I fear that the Biden administration intends to double down on its regulation of the American energy sector while letting China take our place as a global energy leader.

The budget proposal we are discussing today, unfortunately limited in its detail, calls for $14 billion more to be spent on climate across almost every agency. That is the entire President's budget. EPA's overall budget would grow by 20 percent. The Chairman has talked about that.

Part of that requested increase is to fund implementation of climate regulations under the Clean Air Act. I am concerned this request signals a desire to reimpose over-reaching climate regulations.

We want to get to the same place here, I think all of us do, in terms of clean air and less emissions.

West Virginia saw the effects of aggressive climate regulations combined with difficult economic conditions during the Obama administration. I don't want to repeat that history as we come out of this pandemic.

Regulations like the Clean Power Plan had such tremendous implications for States like ours. It created, for me, environmental justice concerns.

You and I have talked about this. I know environmental justice is important to you, and it is to me as well. Without question, the climate regulations of the Obama administration contributed to "disproportionately high and adverse effects on the health of low income populations in West Virginia." The economic decline since 2008 in some parts of my State is shocking.

As John Deskins from West Virginia University testified at a House hearing last month, the decline of the coal industry has cost West Virginia 15,000 jobs and $3.5 billion in direct economic impact. Deskins observed that the concentration of these job losses created a great depression in six southern West Virginia counties.

Economic decline has left behind a cycle of drug abuse, poverty, despair, and health implications.

I think sometimes we struggle to define environmental justice, what it is and what it is not. Executive Order 12898 on Environmental Justice was signed by President Clinton in 1994, and has been implemented by Democrat and Republican Presidents. I think it offers a perspective on environmental justice that we can all agree with.

The Executive Order tasks the EPA and other agencies with "identifying and addressing as appropriate disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations."

Environmental justice is meant to prevent negative impacts on low income populations from regulations before they happen. Environmental justice for West Virginia means recognizing that some regulations can harm communities, and making a decision not to enter a regulation would be maybe the better path.

I look forward to discussing with you how we can work together. I appreciate your openness, I really do, to ensure new climate regulations that could present some harm to communities like I have described in my State and across the country, that we prevent those from moving forward.

I also look forward to discussing other environmental issues, from ensuring safe drinking water, to cleaning up contaminated land, and these are places where I know we can work together.

Thank you again for joining us today, and thank you, Mr. Chairman.

Senator CARPER. Senator Capito, thank you very much for those remarks.

After our Administrator testifies, I am going to step aside, and Senator Capito, if you want to ask the first round of questions, feel free. I will yield to other members of the Committee who may have greater pressing matters to get to.

So with that, Mr. Regan, we are delighted that you are back, and we wish you and your family all the best. Welcome, tell them we said hello, and please proceed.

Thank you.

STATEMENT OF HON. MICHAEL S. REGAN, ADMINISTRATOR, U.S. ENVIRONMENTAL PROTECTION AGENCY

Mr. REGAN. Thank you.

Thank you, Chairman Carper, and Ranking Member Capito, and members of the Committee.

I am grateful for the opportunity to appear before you today to discuss the U.S. EPA's discretionary funding request for fiscal year 2022.

For half a century, EPA has helped provide the American people with clean air to breathe, clean water to drink, and safe, healthy land.

The EPA's dedicated public servants, including seven staff members who have been with the agency since its inception in 1970, work every day to improve the lives of people across this great Nation, and have risen to meet the challenges presented to us as a result of the COVID-19 pandemic.

Earlier this month, President Biden sent to Congress a discretionary funding request for the Environmental Protection Agency at $11.2 billion. We believe this request will help ensure EPA can continue to meet the essential mandate, set the stage for our Nation's economic recovery, and provide the resources necessary to confront our environmental challenges, especially in our most overburdened communities.

The President has seized this moment to reimagine a new American economy that leads the world in advancing clean energy, modernizing our infrastructure while enabling it to withstand the impacts from climate change, and rights the historic wrongs of environmental injustices that have held back generation of Black, LatinX, indigenous, and low income communities. This funding request reflects the understanding that a healthy environment and a healthy economy are not mutually exclusive. They actually go hand in hand.

These investments will provide a tremendous opportunity to leverage American innovation, put people back to work, and protect our communities, our families, and our children from environmental hazard and harm. In short, this request recognizes the profound urgency and existential threat of the climate crisis, and provides EPA with the resources essential for fulfilling our mission to protect human health and the environment, which creating good paying American jobs.

Ensuring access to clean and safe water for all Americans impacts our Nation's climate resilience, and is integral to advancing environmental justice. At EPA, we have seen that investing in water infrastructure is a win-win for public health and economic development. EPA's Water Infrastructure Finance and Innovation Act loan has helped finance $19.4 billion in water infrastructure and helped to create over 47,000 jobs nationwide.

The 2022 funding request requests $3.6 billion for EPA to rebuild our water infrastructure. It is an increase of more than $600 million over the fiscal year 2021 enacted level. This includes targeted increases to the State Revolving Loan Funds to assist States, tribes, and territories with infrastructure projects that help provide safe drinking water and clean water in communities all across this country.

Water infrastructure investments, however, represent only one side of ensuring safe and clean water. The agency will invest resources and expand its efforts to address the pervasive and persistent chemical known as PFAS found in our drinking water.

As part of the President's commitment to tackle PFAS pollution, this funding request provides approximately $75 million to accelerate toxicity studies and funds research to inform the regulatory developments of designating PFAS as hazardous substances, while setting enforceable limits for PFAS under the Safe Drinking Water Act. Additional funds for technical assistance grants have also been set aside for State and local governments to deal with PFAS contamination in their communities.

Under the President's leadership, we are heeding our call of the youth who are courageously urging world leaders to fight the climate crisis with the innovation, fortitude, and resolve that it demands. This budget invests in programs that will help reduce greenhouse gas emissions, including an additional $100 million for air quality grants to go to States and tribes to tackle emission levels on the local and regional scale.

An additional $30 million will also help improve knowledge and impacts of climate change on human health, the environment, and infrastructure, through our research programs, more than doubling EPA's climate change research and additional investments to decrease emissions of methane and HFCs.

Much like climate change, environmental justice underpins all of our work. The pandemic ignited a perfect storm for communities of color and low income communities who already bear the burden, the highest burden of pollution, suffer the highest rates of mortality from heart and lung disease, and now COVID-19, too.

This budget invests $936 million toward a new accelerating environmental and economic justice initiative that will help create jobs, clean up pollution, implement the Justice 40 initiative, and advance racial equity and secure environmental justice for communities who have often been left behind.

With that, Chairman and members of the Committee, the fiscal year 2022 budget will help to ensure EPA can meet the interconnected health and environmental crisis we face, lift up communities who have long been left behind, and put the Nation on a prosperous path for economic recovery. This funding request lays down a marker that EPA is ready to meet the moment.

Thank you for the opportunity to testify. I look forward to our continued partnership, and welcome today's questions.

[The prepared statement of Mr. Regan follows:]

TESTIMONY OF
MICHAEL S. REGAN

ADMINISTRATOR
U.S. ENVIRONEMNTAL PROTECTION AGENCY

BEFORE THE
U.S. SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

April 28, 2021

Thank you, Chairman Carper, Ranking Member Capito and members of the Committee. I am grateful for the opportunity to appear before you today to discuss the U.S. Environmental Protection Agency's discretionary funding request for Fiscal Year 2022.

Before I get to the funding request, I would like to discuss the bold vision laid out by President Biden in the American Jobs Plan. This plan is a transformational investment that puts working people first and will help ensure we reduce pollution and help create good quality jobs.

The American Jobs Plan
In March, President Biden released the American Jobs Plan. This plan recognizes that now is the time for a bold, once-in-a-generation investment in America to put millions of people to work and lay the foundation for economic growth for decades to come by investing in infrastructure.

Infrastructure in the 21st century extends far beyond just roads and bridges. It means investing in our electrical grid and building more resilient transmission. It means revitalizing digital infrastructure to expand access to reliable, high-speed broadband internet in every pocket of the country, especially rural areas and underserved communities. And it also means investing in our drinking water and wastewater infrastructure, cleaning up and restoring our land, and investing in programs to reduce air pollution for our kids.

Guaranteeing clean water for all
The American Jobs Plan proposes a $111 billion investment in water infrastructure, including a $45 billion investment to replace 100% of lead service lines and pipes through the Environmental Protection Agency's (EPA) Drinking Water State Revolving Fund and Water Infrastructure Improvements for the Nation (WIIN) Act grants. Replacing lead service lines is vital for public health and yet EPA estimates that six to 10 million homes in the United States and up to 400,000 schools and daycare centers have lead service lines. The impact of lead exposure, including through drinking water, is a serious public health issue and its adverse effects on children are all too well known. In children, lead can cause irreversible and life-long health effects, including decreasing IQ, focus, and academic achievement.

The plan also would invest $56 billion in grants and low-cost flexible loans to states, Tribes, territories, and disadvantaged communities across the country to upgrade and modernize America's drinking water, wastewater, and stormwater systems, tackle new contaminants, and support clean water infrastructure across rural America. The American Jobs Plan also provides

$10 billion in funding to monitor and remediate PFAS (per- and polyfluoroalkyl substances) in drinking water and to invest in rural small water systems, and household well and wastewater systems, including drainage fields.

In total, these investments will create millions of good paying jobs, including union jobs.

We know from experience that water infrastructure investments not only improve public health—they also create good-paying jobs. Through our State Revolving Funds, EPA has already provided more than $189 billion in financial assistance to nearly 43,000 water quality infrastructure projects and 16,500 drinking water projects. This has created over 300,000 jobs in the last two years alone. Through the Water Infrastructure Finance and Innovation Act (WIFIA) loan program, EPA has provided $9 billion in credit assistance to help finance more than $19 billion for water infrastructure while creating nearly 47,000 jobs and saving ratepayers $4 billion.

Investing in clean buses for kids

When I was a kid growing up in Eastern North Carolina I had to use an inhaler, an experience familiar for far too many kids. That is why the American Jobs Plan proposes to electrify at least 20 percent of our yellow school bus fleet through a new Clean Buses for Kids Program at EPA. We know this type of investment works and that it is important to protect kids on their way to and from school. Since 2008, Congress has provided funding through EPA's Diesel Emissions Reduction Act (DERA) for more than 28,000 school bus upgrades, including more than 4,000 school bus replacements. The Clean Buses for Kids Program is a new program, which would build on the lessons learned from DERA while leaving the existing program intact.

Reducing emissions from school buses has demonstrated positive health benefits for the children who ride them, the drivers, people around school bus loading areas, and the communities in which they operate. These investments will also boost market demand to create jobs, build out infrastructure and support U.S. manufacturing.

Cleaning up and restoring our land

In the 40 years since the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) was signed into law, we have significant progress on cleaning up and restoring our land, but the work is far from over. Under my leadership, EPA will do everything in its power to hold bad actors accountable for environmental degradation and return land to safe and productive use for communities. Communities located within one mile of Superfund sites are disproportionately communities of color and low-income. Remediation of these sites will strengthen climate resilience, improve public health, and expand job opportunities both in these communities, and the nation at large.

The American Jobs Plan proposes a $5 billion investment in the remediation and redevelopment of Brownfield and Superfund sites, as well as related economic and workforce development programs. Cleaning up contaminated sites so they can be returned to productive use can be an engine for economic development across the country. Since Congress started the Brownfields program, federal investments have leveraged $34.6 billion, supported over 176,000 jobs, and thousands of properties have been cleaned up or made ready for reuse.

The FY2022 Discretionary Funding Request
President Biden's proposed FY2022 discretionary request for the Environmental Protection Agency of $11.2 billion advances key EPA priorities, including tackling the climate crisis, delivering environmental justice, and rebuilding core functions at the Agency. The FY2022 discretionary funding request prioritizes working with and supporting state, local and Tribal leaders in expanding capacity in community development, cleaning up toxic waste, and investing in water infrastructure projects that create good paying jobs. Within the EPA topline, $1.8 billion will support investments related to tackling the climate crisis, with more than half supporting environmental justice work. In addition, the request dedicates resources to restoring scientific integrity at the Agency and ensuring the foundation of our decision-making process is grounded in science.

EPA is also seeking additional resources and staff to enforce the environmental laws that Congress has passed so that all companies play on a level playing field and our communities share in public health benefits.

Restoring the Agency
Responding to the environmental crises at hand requires a systemic approach in expanding the Agency's capacity. EPA lost nearly 1,000 dedicated staff over the past four years, and it has affected the Agency's ability to carry out its core duties and functions to protect public health and the environment. The discretionary request invests over $110 million to restore EPA's staff capacity and to rebuild programmatic capabilities that focus on protecting clean air, land, and water.

Restoring capacity across the Agency will strengthen our ability to tackle multiple priorities, from clean air and water, to cutting edge research at the Agency. Restoring the voice of our employees and supporting their efforts—through the best available science—to advance the mission of the Agency has never been more important.

Tackling the climate crisis
Under the Biden-Harris Administration, EPA is reprioritizing addressing climate change with the urgency the crisis demands. The discretionary request invests $1.8 billion in programs to tackle the climate crisis while also delivering environmental justice to marginalized and over-burdened communities, growing the economy, and creating good paying jobs.

This request invests in programs to reduce greenhouse gas emissions, including an additional $100 million for air quality grants to states and tribes to tackle emission levels on a local and regional scale. An additional $30 million is included to improve knowledge of the impacts of climate change on human health and the environment through our research programs—more than doubling EPA's climate change research while providing additional investments to decrease emissions of methane and hydrofluorocarbons.

Prioritizing environmental justice
The communities hardest hit and struggling the most under the weight of the pandemic are often communities of color, lower income communities, and Tribal nations. For decades, many of these same communities have been overburdened with air pollution and other environmental hazards. An individual's skin color or their zip code shouldn't determine whether they have clean air to breathe and water to drink.

This request invests $936 million towards a new Accelerating Environmental and Economic Justice Initiative that will help secure environmental justice for communities who too often have been left behind while creating jobs, cleaning up pollution, and implementing the Justice40 Initiative to advance racial equity. Like climate change, environmental justice underpins the work of the Agency and is an integral part of this national conversation surrounding equality and equity in the nation's communities.

The environmental justice initiative invests in a new community air quality monitoring and notification program, provides additional funds to enforce existing laws meant to protect communities from hazardous pollution, and allocates resources to hold polluters liable in civil and criminal suits. As part of the Justice40 Initiative, $100 million will support development and implementation of a community notification program to monitor and provide real-time data to the public on current environmental pollution. These investments build on the funds provided by the American Rescue Plan, which will help address disproportionate environmental or public health risks in minority and low-income populations resulting from exposure to pollution and the COVID-19 pandemic.

American Rescue Plan
I also want to acknowledge and thank Congress for recognizing EPA's critical role in addressing human health and environmental disparities through the American Rescue Plan. Polluted air, contaminated water, and hazardous waste continue to threaten public health, and the COVID-19 pandemic has compounded the seriousness of such inequities for communities for color and low-income communities across the nation. The American Rescue Plan provides $100 million for the EPA to address these issues; $50 million targeted specifically to advance environmental justice and $50 million to help states, Tribes, and localities improve air quality for their communities. As we work to implement programs and projects to best maximize the use of this funding, I am focused on ensuring these vital funds have the highest and best impact on the ground.

Conclusion
In closing, I want to thank you for the opportunity to be here today. I look forward to our continued partnership and welcome any questions you may have.

Senate Committee on Environment and Public Works
Hearing entitled, *"Hearing on the Fiscal Year 2022 Proposed Budget for the U.S. Environmental Protection Agency"*
April 28, 2021
Questions for the Record for Administrator Michael S. Regan

Senator Markey:

1. Recent testing documented the presence of per- and polyfluoroalkyl substances (PFAS) in a pesticide product sprayed across Massachusetts. Follow-up tests by the Environmental Protection Agency (EPA) found that at least nine PFAS chemicals were leaching from the PFAS-coated plastic containers in which the pesticide product was stored. This disturbing incident highlights serious concerns about the ubiquity of PFAS and their prevalence throughout our supply chains.

    a. When will the EPA designate PFAS as a hazardous substance?

RESPONSE: As EPA's Administrator, tackling PFAS pollution is one of my top priorities. We will take meaningful action, following the science and following the law, to better understand and ultimately reduce the potential risks caused by these chemicals. I am committed to listening to the public and working collaboratively with states, tribes, local governments, industry, water systems, and impacted communities to identify pragmatic approaches that will deliver critical protections across the country. Recently, I established the EPA Council on PFAS (ECP) to strategize the best way to use EPA's authorities, expertise, and partnerships to mitigate and reduce PFAS pollution and protect public health and the environment. I have asked the ECP to make initial recommendations to me within 100 days of the Council's establishment. As an important part of EPA's work to address PFAS pollution, EPA is considering options for designating PFOA and PFOS as CERCLA hazardous substances and is committed to protective steps guided by science and law.

    b. How is the EPA working to phase out the nonessential use of PFAS?

RESPONSE: EPA is working on several PFAS initiatives to gather data, including on current and past uses of PFAS, that will allow EPA to focus research and monitoring efforts to prioritize PFAS actions. We are requiring certain facilities to report to EPA releases of nearly 200 PFAS via the Toxics Release Inventory. EPA has also drafted a proposed rule that would require any company that manufactured PFAS since 2011 to report to EPA, among other things, what they made, how much they made, what it is or was used for, and any health or environmental effects information they have. More broadly, EPA is contemplating the creation of a national testing strategy on PFAS to require, in a targeted way, the development of data and other information we need to bridge the data gaps across the sub-classes of these chemicals.

2. Approximately 144,000 genetically engineered mosquitos are set to be released in the Florida Keys over the coming weeks. Residents and scientists have expressed concern over the lack of environmental and health reviews and independent scientific analysis, as well as the absence of EPA regulations for the use of genetically engineered insects.

    a. Will the EPA rescind the permit to release genetically engineered mosquitoes until after developing new regulations, convening a Scientific Advisory Panel, and deploying caged trials?

RESPONSE: EPA stands by its decision to grant the experimental use permit to Oxitec. EPA's decision was made after extensive evaluation of the best available science, consideration of public input, and consultation with technical experts at the U.S. Centers for Disease Control and Prevention. The experimental use permit contains significant protections, including weekly monitoring and sampling of the mosquito population in the treatment areas. If an unforeseen event occurs, EPA can cancel the experimental use permit at any point during the 24-month period.

Successful field testing of Oxitec's technology could benefit all communities, including low-income areas. The range of disease spreading mosquitoes is rapidly expanding in the United States, and climate change could increase their range. Breeding habitats for these mosquitoes most often overlap with densely populated areas, including urban low-income communities of color. These communities could be at higher risk for exposure to mosquitoes, virus transmission, and chemicals used during mosquito control efforts. The use of species-specific modified mosquitoes has the potential to reduce the use of chemicals for mosquito control, while simultaneously culling populations of mosquitoes that spread disease.

3. Federal funding levels for air quality monitoring and management are notoriously low, and have remained unchanged for nearly two decades.
    a. Would additional funding for air quality monitoring and management help support EPA's air quality goals?
    b. How could additional support be deployed to help communities with poor air quality, such as Chelsea and Springfield in Massachusetts?

RESPONSE: Yes. For FY 2022, EPA requests a $100 million increase for air quality grants to states and tribes to help expand the efforts of air pollution control agencies to implement their programs. Every American deserves to know their exposure to air pollution. Toward that goal, and in concert with section 222 of the Executive Order on Tackling the Climate Crisis at Home and Abroad, the Budget invests $100 million to develop a community air quality monitoring and notification system to provide real-time data to overburdened and marginalized communities and enforcement officials. By maximizing the transparency of air pollution levels at the community scale, we can better ensure that places with the most significant exposure are being targeted for action and measurable progress.

As described in the President's budget, in FY 2022, EPA will initiate a nationwide effort to ensure and enhance the resiliency, capacity, and capability of air monitoring systems for National Ambient Air Quality Standards (NAAQS) and local-scale monitoring implemented by state, local, and tribal organizations (SLTs) through: 1) system modernization (e.g., infrastructure improvements, enhanced network automation, greater system reliability, and data integration for assessments); 2) expanded functionality (e.g., increased use of continuous monitoring equipment); and 3) local-scale monitoring to, for example, characterize air toxics and better address air quality burdens in environmental justice communities. Key to the success of this effort will be close, meaningful collaboration with our state, local and tribal air partners, including those in Massachusetts. EPA continues to work closely with local communities and states. For example, with EPA assistance, the Massachusetts Department of Environmental Protection recently established a new monitoring location in Chelsea to help address community concerns about air quality. More resources could help Massachusetts and other states to assess local community needs and respond appropriately.

Senator Kelly:

1. The Coronavirus Response and Relief Supplemental Appropriations Act, which was passed in December of last year, included $638 million for a first-of-its-kind water bill utility assistance program. While this program is currently temporary, and administered by HHS, I support efforts to make this program permanent. Given that EPA is the primary federal agency which provides assistance to drinking water utilities, what role is EPA playing to support HHS in establishing this program? And if a water utility assistance program is made permanent, what role do you believe EPA should play in such a program?

   RESPONSE: EPA appreciates Congress' assistance in appropriating more than $1 billion to support low-income water ratepayers through a new program at the Department of Health and Human Services (HHS). EPA is actively assisting our colleagues at HHS in their critical work to develop and implement this program. At the same time, this Committee has continued to shine a light on these important issues through the Drinking Water and Wastewater Infrastructure Act (S. 914), which includes many provisions related to water and wastewater affordability. EPA looks forward to providing technical assistance to Congress on these efforts and any additional programs Congress creates.

2. It is clear that the water and wastewater infrastructure of Arizona and the Southwest is put at risk by climate change and extreme weather events. The state is already experiencing dust storms, heavy thunderstorms, flash flooding and high winds, among other impacts. The Central Arizona Project has noted that these events are stressing existing infrastructure, and "can cause significant damage to [water] infrastructure that require higher and more frequent levels of maintenance." How does EPA's FY22 budget approach water and wastewater infrastructure resiliency?

RESPONSE: The Budget provides a total of $3.6 billion for water infrastructure, an increase of $625 million over FY 2021 enacted levels. EPA will use these funds to help finance the upgrade and replacement of aging infrastructure for drinking water and wastewater systems and make them more resilient to the impacts of climate change.

a. In 2018, America's Water Infrastructure Act created a new Drinking Water System Infrastructure Resilience and Sustainability Program at EPA, which is intended to help small and disadvantaged community water systems prepare their infrastructure to withstand the effects of climate change and extreme weather. What are the successes and failures of this program to date, and do you believe it could or should be expanded to help promote water infrastructure resiliency in even more communities?

RESPONSE: As you note, Congress authorized a new Drinking Water System Infrastructure Resilience and Sustainability Program in America's Water Infrastructure Act of 2018, and Congress provided first-time appropriations for this program in Fiscal Year 2020. EPA is in the final stages of preparing a Request for Applications (RFA) for this inaugural round of funding. At the same time, EPA appreciates Congress' continued attention toward increasing the resilience of our nation's water infrastructure to climate change and extreme weather, including through the Drinking Water and Wastewater Infrastructure Act (S. 914). EPA looks forward to providing technical assistance to Congress as it considers this important issue. We are confident the Agency would be able to implement an expanded program, which the Budget would fund at $5 million over FY 2021 enacted levels.

Ranking Member Capito:

1. At the recent White House Climate Summit, you stated that you intend to tackle climate issues through "urgent" and "aggressive" actions. President Biden's budget proposal provides EPA with $110 million to "to restore EPA's critical staff capacity and to rebuild programmatic capabilities." This increase includes $48 million for the Office of Air and Radiation to focus on implementation of Clean Air Act climate regulations. Would any part of the $48 million for increasing staff capacity in the Office of Air and Radiation be used to develop a reiteration of the Clean Power Plan?

RESPONSE: The FY 2022 President's Budget is rooted in EPA's commitment to advancing environmental justice, tackling climate change, protecting public health, improving infrastructure, and rebuilding the EPA workforce to accomplish the EPA's mission.

The power sector is a leading source of many harmful air pollutants, including sulfur dioxide, nitrogen oxides, and mercury. It is also the second-largest source of greenhouse gas emissions in the United States. EPA staff are working to determine the next steps on power plants—guided by science, the law, and our Clean Air Act

obligations—to protect public health and the environment and advance environmental justice and ensure reliable, affordable electricity.

2. A significant proportion of the $2 billion funding increase for EPA proposed by President Biden is focused on the air and climate policy area. How is EPA prioritizing protecting other aspects of the environment, such as water and land, and does this budget request reflect this prioritization?

   RESPONSE: In the FY 2022 Budget, EPA proposes to increase funding for several existing water infrastructure programs, including the Clean Water State Revolving Funds (CWSRF), Drinking Water State Revolving Funds (DWSRF), the Water Infrastructure Finance and Innovation Act (WIFIA) program, and grant programs authorized in the America's Water Infrastructure Act of 2018 (AWIA) and the Water Infrastructure Improvements for the Nation Act of 2016 (WIIN). Specifically, the FY 2022 Budget provides $3.2 billion across the two SRF programs, a $464 million increase above the FY 2021 enacted levels, representing nearly 30 percent of EPA's total resource request. These financing programs will advance the Agency's ongoing commitment to infrastructure repair and replacement while creating hundreds of thousands of good-paying jobs across the country.

   Many communities face the challenge of cleaning up contaminated lands so that they can be redeveloped and reused. The FY 2022 request enables the Agency to expedite the cleanup of hazardous waste sites that litter communities across the country, particularly low-income communities and communities of color. Of the total funding requested for Superfund, $1.108 billion and 1,261 FTE would support Superfund cleanup programs, a $299.4 million increase over last year. This investment will enable the start of cleanup work at more than 20 National Priority List (NPL) sites with new remedial construction projects currently awaiting funding. It also will accelerate cleanup work at more than 15 NPL sites with large, ongoing construction projects, which require a substantial funding allocation over multiple years, and allow for enhanced engagement at lead-contaminated sites.

3. Is climate the top priority for EPA's regulatory development and implementation?

   RESPONSE: Developing policy and regulatory action to address the climate crisis while advancing environmental justice is one of the top priorities for EPA.

4. Do you believe that the US must end coal use to meet the targets that President Biden laid out in reducing greenhouse gas emissions by 50 to 52 percent from 2005 levels by the end of this decade?

   RESPONSE: When considering regulatory policies related to the power sector, EPA will adhere to science and the law—including our obligations to protect public health under the Clean Air Act. EPA also will consider relevant market trends and technological innovations, including advances in Carbon Capture and Storage (CCS) technology that could help to address pollution and keep coal in the mix.

5. Do you believe that China should be considered a "developing" country when pledging to emissions reductions in international agreements?

RESPONSE: China is the world's second largest economy and is the world's largest greenhouse gas emitter. The Paris Agreement calls for action by all countries to reduce greenhouse gas emissions. China's efforts to reduce emissions this decade need to be consistent with China's position as a leading economy and the world's largest GHG emitter.

6. The President recently announced his intent to reach a 100-percent carbon emissions-free power sector by 2035 to comply with the US target under the Paris Agreement. Do you believe EPA has the statutory authority to issue regulations that require elimination of carbon emissions from the power sector by 2035?

RESPONSE: In 2007, the U.S. Supreme Court, in *Massachusetts v. EPA*, found that the Clean Air Act obligates EPA to regulate emissions of greenhouse gases, given their threat to public health and welfare. EPA has found that six greenhouse gases—including carbon dioxide (CO_2)—"may reasonably be anticipated both to endanger public health and to endanger public welfare." When considering future regulatory policies related to the power sector, EPA will adhere to science and the law, including our obligations to protect public health under the Clean Air Act.

7. Do you intend to regulate a power plant's carbon dioxide emissions beyond, or "outside," the fence line?

RESPONSE: The Agency will review prior efforts to reduce greenhouse gas emissions from power plants, including the Clean Power Plan and the Affordable Clean Energy rules, and apply lessons learned from those efforts to moving EPA forward. EPA will continue working with stakeholders and the rest of the Administration, as well as with Congress, to address greenhouse gas emissions from power plants.

8. How do you plan to ensure that low-income families are not impacted by job losses or energy rate hikes associated with closing down more power plants?

RESPONSE: As a matter of course in agency rulemakings and per relevant federal executive orders and guidance, EPA performs regulatory impact analyses to quantify, when feasible, the likely benefits and costs of certain regulatory options. When relevant to the rulemaking, EPA examines industry compliance costs, impacts on fuel and electricity prices, and impacts on electricity bills. EPA takes these quantified costs and benefits into account when choosing a regulatory path.

The cost of carbon pollution-free electricity sources has dropped dramatically over the prior decade. It is now cheaper to build new carbon pollution-free electricity

than to continue to run polluting power plants across a growing majority of the country. We expect the clean electricity system to be affordable and reliable.

Through the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization, EPA is working with other federal agencies to make sure that we support hard-hit energy workers and communities by creating good-paying union jobs and spurring economic revitalization and remediating environmental degradation. The Interagency Working Group will "promote job-creating investments in communities already impacted by coal mine and power plant closures and will also be pro-active, investing now in the communities likely to be impacted by additional, near-term declines in coal production and generation from coal-fired power plants." (Initial Report to the President on Empowering Workers Through Revitalizing Energy Communities, April 2021, *available at* https://netl.doe.gov/IWGInitialReport.) The working group's initial report identified $38 billion of potentially available funding that could be used to provide immediate investments in energy communities, including EPA programs to remediate and redevelop brownfields, which create jobs as well as clean up environmental hazards. The working group has engaged stakeholders from energy communities, including labor unions; community development organizations; local, regional, and tribal governments; the private sector; and philanthropic interests, and will continue to expand its outreach to key constituencies as it shapes federal support for economic revitalization of these communities.

9. With the Agency's definition of "environmental justice" in mind, do you believe that rural communities hurt by environmental regulations applied to the energy sector are environmental justice communities?

RESPONSE: EPA defines "environmental justice" as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." This goal will be achieved when everyone enjoys (1) same degree of protection from environmental and health hazards, and (2) equal access to the decision-making process to have a healthy environment in which to live, learn, and work.

As a matter of course in agency rulemakings and per relevant federal executive orders and guidance, EPA performs regulatory impact analyses to quantify, when feasible, the likely benefits and costs of certain regulatory options. When relevant to the rulemaking, EPA examines industry compliance costs, impacts on fuel and electricity prices, impacts on electricity bills, and net employment impacts. EPA takes these quantified costs and benefits into account when choosing a regulatory path. On April 7, 2021, I directed EPA staff to take immediate and affirmative steps to incorporate environmental justice considerations into their work, including assessing impacts to pollution-burdened, underserved, and Tribal communities in regulatory development processes and considering regulatory options to maximize benefits to these communities.

10. When EPA opened nominations for the National Environmental Justice Advisory Committee (NEJAC), the website stated that they were not prioritizing representation from EPA Regions 3, 4, 5, or 6. Why did you make this decision?

    RESPONSE: A hallmark of the NEJAC has always been that it has both a broad cross-stakeholder representation as well as a broad regional representation. During new membership recruitment, EPA regularly advertises which categories and geographic areas are currently most in need of representation in order to maintain balance, although all are still welcomed and encouraged to apply as EPA holds applications received over several cycles of consideration.

    The current list of NEJAC members, which includes representation from EPA Regions 3, 4, 5, and 6, is available at: https://www.epa.gov/environmentaljustice/national-environmental-advisory-council-nejac-members-and-biographies.

11. Will you commit to increase rural representation on NEJAC from EPA Regions 3, 4, 5, and 6?

    RESPONSE: When selecting members for the NEJAC, EPA works to ensure representation from rural areas as part of our commitment to diversity.

12. The Electric Power Research Institute (EPRI) recently published a report that identified major issues with how the "Social Cost of Greenhouse Gas" (SC-GHG)—separate calculations of the cost of carbon dioxide, nitrous oxide, and methane—is being used to conduct cost-benefit analysis for environmental regulations and how the SC-GHG is calculated. When asked about submitting revisions to the SC-GHG through a full regulatory review process, Janet McCabe, the then-nominee for EPA Deputy Administrator, said "I don't think you will have any disagreement from us that any decisions such as [revising the SC-GHG] be based on sound science and well vetted studies that folks have an opportunity to see and weigh in on." Do you agree with Ms. McCabe that any SC-GHG estimates should be based on figures that go through the regulatory review process and public comment?

    RESPONSE: Executive Order 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, reaffirms that "[a]n accurate social cost is essential for agencies to accurately determine the social benefits of reducing greenhouse gas emissions when conducting cost-benefit analyses of regulatory and other actions." The E.O. instructs the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) to publish an interim update to the SC-GHG estimates within 30 days and to publish a more comprehensive update by January 2022. In doing so, the E.O. instructs the IWG to consider the recommendations of the National Academies of Science, Engineering, and Medicine (NASEM) as reported in *Valuing Climate Damages: Updating Estimation of the*

Social Cost of Carbon Dioxide **(NASEM 2017[1]) and other pertinent scientific literature; solicit public comment; engage with the public and stakeholders; seek the advice of ethics experts; and ensure that the SC-GHG estimates reflect the interests of future generations in avoiding threats posed by climate change.**

The interim SC-GHG estimates were published in the February 2021 ***Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990*** **(IWG 2021[2]). These estimates were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. In developing the SC-GHG estimates in 2010, 2013, and 2016, the IWG used consensus-based decision making, relied on peer-reviewed literature and models, and took steps to disclose limitations and incorporate new information by considering public comments and revising the estimates as updated research became available (U.S. GAO 2014[3]).**

Going forward, EPA commits to continuing to participate in the IWG's consensus driven process for making evidence-based decisions pertaining to the update of SC-GHG methodologies that are guided by the best available science and input from the public, stakeholders, and peer reviewers. Although it is the government's position that the IWG's process for developing SC-GHG estimates is not a rulemaking subject to the Administrative Procedure Act's notice and comment requirements, the IWG has committed to early and robust interaction with the public and stakeholders, and plans to solicit public comments on the updated estimates. While the IWG assesses the current state of the science in each component of the SC-GHG modeling exercise, the IWG is already asking for public comment on how best to incorporate the latest, peer-reviewed science to develop an updated set of SC-GHG estimates. The IWG published a ***Federal Register*** **notice on May 7, 2021 soliciting comment on the February 2021 interim TSD as well as on how best to incorporate the latest peer-reviewed scientific literature in order to develop an updated set of SC-GHG estimates.**

13. The "Draft Regulatory Impact Analysis [RIA] for Phasing Down Production and Consumption of Hydrofluorocarbons (HFCs)"[4] uses a "Social Cost of Hydrofluorocarbons (SC-HFCs)" to estimate the economic benefits of reducing emissions of HFCs. To my knowledge, this is the first time EPA has publicly estimated SC-HFCs and the first use of SC-HFCs in a regulatory context. How does the use of SC-

[1] National Academies of Sciences, Engineering, and Medicine (NASEM). 2017. Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide. Washington, D.C.: National Academies Press.
[2] Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government. *Available at* https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.
[3] U.S. Government Accountability Office (GAO). 2014. Regulatory Impact Analysis: Development of Social Cost of Carbon Estimates. GAO-14-663. July. Available at: https://www.gao.gov/products/GAO-14-663.
[4] https://www.epa.gov/sites/production/files/2021-05/documents/ria_omb_043021_0.pdf

HFCs prior to peer review or public input align with your commitment to scientific integrity and transparency?

RESPONSE: The SC-HFC estimates were developed using methodologies that are consistent with the methodology underlying the social cost of carbon, methane, and nitrous oxide estimates (SC-CO_2, SC-CH_4, and SC-N_2O) presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990* (IWG 2021[5]). These methods were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. In particular, the approach used for developing the SC-HFC estimates used in the Draft Regulatory Impact Analysis (RIA) mirrors that of the peer-reviewed SC-CH_4 and SC-N_2O estimates (Marten et al. 2015[6], IWG 2016[7]), but is applied to HFCs based on data published as part of the IPCC's assessment reports. The modeling approach that extends the IWG SC-CO_2 methodology to non-CO_2 GHGs, has undergone multiple stages of peer review and estimates using this non-CO_2 methodology in regulatory analysis have been subject to public comment. The Marten et al. (2015) estimates underwent a standard double-blind peer review process prior to journal publication. EPA then sought additional external peer review of technical issues associated with its application to regulatory analysis. Following the completion of the independent external peer review of the application of the Marten et al. (2015) estimates, EPA began using the estimates in the primary benefit-cost analysis calculations and tables for a number of proposed rulemakings in 2015, and considered the public comments received before using them in final regulatory analyses in 2016. OMB has determined that the use of this methodology is consistent with the OMB's guidelines for conducting peer review and regulatory analysis.

EPA has invited the public to provide comment and data that would inform various analytic matters, including the use and application of the SC-HFC estimates in the Draft RIA. The Draft RIA was made available in the docket for the rule when the proposed rule was published in the *Federal Register* on May 19, 2021, which began a public comment period to close on July 6, 2021. Additionally, the Draft RIA was published on the EPA website. EPA will consider all public comments received, including those on SC-HFCs.

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[5] Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government. Available at: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

[6] Marten, A.L., Kopits, E.A., Griffiths, C.W., Newbold, S.C., and A. Wolverton. 2015. Incremental CH4 and N2O Mitigation Benefits Consistent with the U.S. Government's SC-CO2 Estimates. Climate Policy 15(2): 272-298.

[7] Interagency Working Group on the Social Cost of Greenhouse Gases (IWG). 2016. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August. United Stated Government. Available at: https://www.whitehouse.gov/omb/information-regulatory-affairs/regulatory-matters/#scghgs.

14. Is the Interagency Working Group on Social Cost of Greenhouse Gases including the SC-HFCs in its ongoing review of the social cost of greenhouse gases?

RESPONSE: EPA continues to participate in the IWG that is in the process of meeting the directives set forth in Executive Order 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, pertaining to the update of SC-GHG estimates to ensure that they reflect the best available science. The E.O. specifically charges the IWG with considering CO_2, CH_4, and N_2O. If the IWG updates its methodology for evaluating the social costs of non-CO_2 GHGs, EPA will consider that information in developing future analyses.

15. The Final Information Quality Bulletin for Peer Review details that a scientific assessment is considered "highly influential"' if the agency or the Office of Information and Regulatory Affairs (OIRA) Administrator determines that the dissemination: could have a potential impact of more than $500 million in any one year on either the public or private sector; or that the dissemination is novel, controversial, or precedent-setting, or has significant interagency interest. [8]

    a. Does the development and use of SC-HFCs meet the threshold of highly influential scientific assessments set forth in the Final Information Quality Bulletin for Peer Review?

    b. Please explain why or why not, including whether you support undertaking an independent peer review before using SC-HFCs.

RESPONSE: The SC-HFC estimates were developed using methodologies that are consistent with the methodology underlying the social cost of carbon, methane, and nitrous oxide estimates (SC-CO_2, SC-CH_4, and SC-N_2O) presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990*, which were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. The application of these estimates in the draft RIA is consistent with EPA's Peer Review Handbook 4th Edition (U.S. EPA 2015[9]), and OMB has determined that the use of this methodology is consistent with the OMB's guidelines for conducting peer review and regulatory analysis.

Further, as stated in Response 13, above, EPA has invited the public to provide comment and/or data that would inform various analytic matters, including the use and application of the Social Cost of Hydrofluorocarbons in the Draft Regulatory Impact Analysis. The Draft Regulatory Impact Analysis was made available in the

[8] https://www.govinfo.gov/content/pkg/FR-2005-01-14/html/05-769.htm.
[9] U.S. EPA. 2015. Peer Review Handbook 4th Edition. Available at: https://www.epa.gov/osa/peer-review-handbook-4th-edition-2015.

docket for the rule when the proposed rule was published in the *Federal Register* on May 19, 2021 and is open for public comment through July 6, 2021.

16. While the EPA Office of Research and Development leads the Agency's scientific research activities, EPA's program offices, as well as state regulatory agencies, also carry out research and data analysis activities. How will you handle instances in which conflicting scientific opinions and data regarding peer-reviewed work exists within EPA?

RESPONSE: Rigorous analysis and the frank expression of scientific views is a legitimate and necessary aspect of the scientific endeavor. Challenging ideas and assumptions guards against inadequate science, flawed analysis, and insufficient evidence. EPA has developed and implements a "differing scientific opinion policy" that recommends a progression of approaches that employees and managers can use to encourage the expression and satisfactory resolution of differing scientific opinions. That policy is available at https://www.epa.gov/osa/approaches-expressing-and-resolving-differing-scientific-opinions.

17. How will you handle instances in which there are conflicting conclusions between EPA and your state partners?

RESPONSE: EPA will work with state and tribal partners to protect public health and the environment. There are certain baseline standards we expect states to meet to ensure we are fulfilling the public health and environmental protections that our communities deserve, and EPA is committed to ensuring the protection of communities regardless of where a person lives. However, the Agency believes the best way to create sustainable, durable environmental policy is to work collaboratively with states and tribes to meet EPA's statutory obligations on behalf of the American people.

18. Do you agree that posting all guidance documents on a public and easily accessible website is an effective measure to promote transparency in Agency operations?

RESPONSE: EPA continues to believe in the importance of transparency and will continue to make relevant guidance available to the public on the EPA website.

19. Do you have plans to reinstate the EPA's searchable access portal websites for guidance documents?

RESPONSE: Guidance documents are easily accessible on the EPA website, organized by topic, and may be found by using widely available search tools or by searching within a specific EPA web page that is of interest. EPA web pages also have a Contact Us link at the bottom of the page.

20. In explaining the rationale for rescinding EPA's 2020 guidance rule, EPA stated the rule "deprives the EPA of necessary flexibility in determining when and how best to issue public guidance based on particular facts and circumstances, and unduly restricts the

EPA's ability to provide timely guidance on which the public can confidently rely." Can you please explain which aspects of the 2020 rule resulted in this determination?

RESPONSE: The 2020 rule established unnecessary or duplicative procedures and as a result limited EPA's discretion to issue timely guidance.

21. EPA is frequently subject to legal action, including citizen suits. What is your approach to ensuring transparency and public participation in settlement agreements?

RESPONSE: The EPA's mission is to protect human health and the environment, a hugely important task that requires public trust and accountability. EPA is committed to operating in a transparent manner as we restore integrity and public trust in the Agency's operations and decision-making. I will ask my legal team to brief me on this issue.

22. Will you commit to providing the public with notice and an opportunity to comment on any proposed settlement agreements?

RESPONSE: The EPA's mission is to protect human health and the environment, a hugely important task that requires public trust and accountability. EPA is committed to operating in a transparent manner as we restore integrity and public trust in the Agency's operations and decision-making. The Agency will continue to follow all statutory requirements in this regard such as Clean Air Act section 113(g). In addition, consistent with President Biden's Executive Orders, the Agency is evaluating a directive from the last Administration on this topic.

23. On March 10, 2021, Office of Chemical Safety and Pollution Prevention (OSCPP) Acting Assistant Administrator Michal Freedhoff sent an email to the OCSPP staff and provided three alleged examples of political interference that compromised the integrity of EPA science. The Agency has a formal process associated with the EPA Scientific Integrity Policy for conducting reviews of scientific integrity violations and issues formal determinations at the conclusion of the process.

    a. Was this formal process completed for each of the three examples prior to the March 10th email being sent?

RESPONSE: President Biden's Memorandum on Scientific Integrity and Evidence-Based Policymaking directs agencies to make evidence-based decisions guided by the best available science and data, which are central to sound policy. This Memorandum sends a clear message that the Biden-Harris Administration will protect scientists from political interference and ensure they can think, research, and speak freely to provide valuable information and insights to the American people.

EPA is committed to upholding scientific integrity and has taken action to address these instances that compromised the integrity of EPA science. For example, the

EPA Office of the Inspector General (OIG) completed an investigation regarding EPA's 2018 registration decision for dicamba and found that then-OCSPP senior leadership at the time of the 2018 decision directed career staff to change or omit information from scientific documents. The Agency has responded to the OIG's report and is implementing several actions to ensure that our pesticide registration decisions are free from political interference and that the agency's scientific integrity policy is upheld. In the instance of TCE, the Scientific Integrity Official is currently reviewing this case for potential scientific integrity violations. Lastly, the version of the PFBS assessment that was published on January 19, 2021 was compromised by political interference as well as infringement of authorship and the scientific independence of the authors' conclusions. This constituted a violation of EPA's Scientific Integrity Policy, and it was removed from the EPA website on February 9, 2021. In these, and other instances, we are working to restore scientific integrity and evidence-based policymaking throughout EPA, including through the use of best available science.

b. Please identify any other examples you are aware of and whether the formal process has been completed for them.

RESPONSE: EPA is committed to upholding scientific integrity. The EPA Scientific Integrity Annual Reports summarizes the activities and initiatives that supported the implementation of EPA's Scientific Integrity Policy, as well as giving an annual update on the number and type of queries received. These are available at https://www.epa.gov/osa/annual-reports-scientific-integrity-polices-and-additional-resources.

24. Will reviews and determinations conducted under the Scientific Integrity Policy be made public?

RESPONSE: The EPA Scientific Integrity Annual Reports summarize the activities and initiatives that support the implementation of EPA's Scientific Integrity Policy, as well as giving an annual update on the number and type of queries received. The report includes the type and topic of the query, as well as the number of withdrawn, substantiated, and unsubstantiated allegations. EPA does not disclose detailed information about specific queries or allegations in its Annual Report. Allegations of research misconduct or waste, fraud, or abuse are referred to the Office of Inspector General.

25. As part of the development of the "Human Health Toxicity Assessment for PFBS," OCSPP staff issued a memorandum that expressed a difference of scientific opinion with the Office of Research and Development staff. Have the career staff in those two offices resolved this difference of opinion?

RESPONSE: The PFBS assessment that was released on April 8, 2021 went through all appropriate reviews, includes input EPA received from external peer review, and was authored by expert career scientists in EPA's Office of Research and

Development (ORD). OCSPP was included in the review process. ORD and OCSPP staff scientists agree on the foundational science of the assessment and are committed to working together to protect human health and the environment.

26. Can you identify which changes to the PFBS assessment violated the EPA Scientific Integrity Policy in your judgement?

RESPONSE: The version of the PFBS assessment that was published on January 19, 2021 was compromised by political interference as well as infringement of authorship and the scientific independence of the authors' conclusions. This constituted a violation of EPA's Scientific Integrity Policy, and it was removed from the EPA website on February 9, 2021.

27. In March, you fired all 44 members of the Science Advisory Board (SAB) and the 7 members of the Clean Air Scientific Advisory Committee (CASAC). You stated that purging the advisory committee was necessary since they were "out of balance," and that the problem was not "the individuals that were in the seats, but more so [that] the collective seats were not representative of the needs that the Agency has." Can you clarify what your understanding of the current "needs of the Agency" are?

RESPONSE: This was not a political decision. After consulting with career staff and career scientists, I determined that the Science Advisory Board and Clean Air Scientific Advisory Committee needed a fresh start to ensure the quality and independence of their science advice. In 2019, the Government Accountability Office concluded that the previous administration did not follow EPA's normal, established process for recruiting and appointing experts to these boards, which are critical to the integrity of EPA's regulatory process.[10] This is a process that Democratic and Republican administrations have always followed, until the Trump administration. To move forward, we thanked current members for their service and sent out a *Federal Register* notice to recruit new members. We have invited former members to reapply. We will follow standard processes for identifying and appointing top experts in their fields. This will ensure that EPA is receiving the best and most scientifically sound input on all of EPA's priorities, including climate change and environmental justice. EPA will move quickly and expects to have the SAB and CASAC reset within this fiscal year.

28. GAO reported in 2019 that the SAB member composition was about 50 percent academic affiliation, with the other 50 percent including governmental, industry, NGO, and consultants. Do you view this as balanced?

RESPONSE: The Federal Advisory Committee Act requires that a committee be balanced in points of view for the function the committee is to perform. The SAB is a scientific and technical committee, not a representative committee. As such, the balance in points of view pertains to scientific points of view, not organizational affiliation (which are more pertinent for representative committees). Scientific

[10] https://www.gao.gov/products/gao-19-280

points of view pertain mainly to scientific and/or technical expertise, knowledge, and experience. However, they can be influenced by geographical, economic, social, and cultural factors, as well as educational backgrounds and organizational affiliation. Therefore, organizational affiliation is only one part of the considerations for balance for a scientific/technical Federal Advisory Committee (FAC). Agency policy requires all FAC membership to be reviewed by the Office of General Counsel and the Federal Advisory Committee Management Division to ensure that the committees are balanced in points of view for the function the committee is to perform.

29. In January 2009, the SAB had the following membership—33 academic, two governmental, three industry, and two NGOs. Do you view this as balanced?

RESPONSE: The Federal Advisory Committee Act requires that a committee be balanced in points of view for the function the committee is to perform. The SAB is a scientific and technical committee, not a representative committee. As such, the balance in points of view pertains to scientific points of view, not just organizational affiliation (which are more pertinent for representative committees). Scientific points of view pertain mainly to scientific and/or technical expertise, knowledge, and experience. However, they can be influenced by geographical, economic, social, and cultural factors, as well as educational backgrounds and organizational affiliation. Therefore, organizational affiliation is only one part of the considerations for balance for a scientific/technical Federal Advisory Committee (FAC). Agency policy requires all FAC membership to be reviewed by the Office of General Counsel and the Federal Advisory Committee Management Division to ensure that the committees are balanced in points of view for the function the committee is to perform.

30. EPA has stated that the plan is to reconstitute both panels by the end of September. What is the impact of not having a functioning SAB or CASAC for nearly half a year?

RESPONSE: Having CASAC and SAB in place before the next fiscal year (10/1/21) remains our goal, and we are on target at this point to meet that schedule. Running the public process for nominations and public comment, analyzing nominations, and working towards final decisions, then hiring new members as Special Government Employees takes several months from start to finish. During this reset, SAB and CASAC are not available for their peer review functions, but once seated, these Federal Advisory Committees will quickly get into the workflow and contribute to multiple activities in FY22.

31. When reviewing the Trump Administration's decision to maintain the particulate matter (PM) National Ambient Air Quality Standards (NAAQS), the Clean Air Scientific Advisory Committee's (CASAC) peer review of the 2020 proposal to retain the standard found that, "CASAC also finds, in agreement with the EPA, that the available evidence does not reasonably call into question the adequacy of the current 24-hour PM2.5 standard, PM10 standard, or secondary PM standards and concurs that they should be

retained." Can you please explain your decision to revisit standards given they were supported by CASAC?

RESPONSE: Executive Order 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, directed Federal agencies to immediately review, and take action to address certain Federal regulations taken during the last four years that conflict with national objectives to improve public health and the environment. The final rule entitled, "Review of the National Ambient Air Quality Standards for Particulate Matter," 85 Fed. Reg. 82684 (December 18, 2020), is one such rule that EPA was directed to review.[11]

Following that review, on June 10, EPA announced that it will reconsider the previous administration's decision to retain the particulate matter (PM) National Ambient Air Quality Standards (NAAQS), which were last strengthened in 2012. EPA is reconsidering the December 2020 decision because available scientific evidence and technical information indicate that the current standards may not be adequate to protect public health and welfare, as required by the Clean Air Act. EPA's 2020 Policy Assessment concluded that the scientific evidence and information support revising the level of the annual standard for the PM NAAQS to below the current level of 12 micrograms per cubic meter while retaining the 24-hour standard. The Agency also received numerous petitions for reconsideration as well as lawsuits challenging the December 2020 final action. The previous CASAC, which was constituted under a shadow of process irregularities, recommended retaining the current 24-hour standard and did not reach consensus on the annual standard. Some CASAC members supported retaining the current standard, while others supported revision. Opinions differed on how to interpret recent epidemiologic studies reporting health effect associations and what those studies mean in judging the adequacy of the current annual standard. As such, a review of the standards is warranted.

EPA will move expeditiously to reconsider the decision to retain the particulate matter NAAQS, in a manner that adheres to rigorous standards of scientific integrity and provides ample opportunities for public input and engagement. As part of this process, the Agency will develop a supplement to the 2019 Final Integrated Science Assessment (ISA) that will take into account the most up-to-date science, including new studies in the emerging area of COVID-related research.

32. According to emails obtained through a Freedom of Information Act (FOIA) request, Democratic Attorneys General consulted with EPA Office of Air and Radiation (OAR) Acting Assistant Administrator Joseph Goffman on using a more stringent ozone National Ambient Air Quality Standard (NAAQS) as a "backdoor" method to regulate greenhouse gas (GHG) emissions. Do you believe the NAAQS program should be used as a "backdoor" to directly or secondarily regulate greenhouse gases?

[11] Fact Sheet: List of Agency Actions for Review, January 20, 2021, available at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/20/fact-sheet-list-of-agency-actions-for-review/.

RESPONSE: When considering future regulatory policies related air pollution, EPA will adhere to science and the law, including our obligations to protect public health under the Clean Air Act.

33. On February 5, 2021, EPA removed the briefing paper titled "Renewable Energy Waste Streams: Preparing for the Future" from the EPA website and updated the landing page and the associated press release stating that the briefing paper "did not follow the appropriate review process and it contained misleading and incorrect information." Can you please describe which aspects of the briefing paper were identified as "misleading and incorrect information"?

RESPONSE: EPA's career subject matter experts found the briefing paper to contain misleading and incorrect information. The paper also failed to position the concerns with waste from renewable energy technologies either in the context of their benefits for air pollution and climate change or in the context of the many significant waste management challenges from other, non-renewable energy sources. Therefore, EPA made the decision to archive this briefing paper and remove it from the EPA's website. https://www.epa.gov/aboutepa/archived-briefing-paper-january-2021. EPA has no plans to revisit this paper, but the Office of Land and Emergency Management continues to evaluate and implement policies and programs regarding emerging waste streams to reduce the amount of waste disposed in landfills and promote waste prevention and materials reuse across waste generation sectors.

34. Does the EPA plan to post a corrected version of the briefing paper?

RESPONSE: EPA's career subject matter experts found the briefing paper to contain misleading and incorrect information. The paper also failed to position the concerns with waste from renewable energy technologies either in the context of their benefits for air pollution and climate change or in the context of the many significant waste management challenges from other, non-renewable energy sources. Therefore, EPA made the decision to archive this briefing paper and remove it from the EPA's website. https://www.epa.gov/aboutepa/archived-briefing-paper-january-2021. EPA has no plans to revisit this paper, but the Office of Land and Emergency Management continues to evaluate and implement policies and programs regarding emerging waste streams to reduce the amount of waste disposed in landfills and promote waste prevention and materials reuse across waste generation sectors.

35. During the hearing, you stated that EPA is "looking at the science behind designating PFAS as a hazardous substance." Specifically, what scientific information is EPA evaluating related to designating PFAS as a hazardous substance?

RESPONSE: EPA is looking at various types of scientific information related to designating certain PFAS, specifically PFOA and PFOS, as CERCLA hazardous substances. This information includes the most up to date chemical and physical

characteristics, toxicity and kinetics, environmental prevalence, and manufacturing and use data.

36. During the hearing, I appreciated your commitment to transparency regarding the development of President Biden's pledged Nationally Determined Contribution (NDC). You stated: "EPA is central to the NDC number that was developed" and that "we attempted to quantify EPA's role and its contribution to meeting that NDC." You stated, "I think the information that we generated that focuses on conceptually where these regulations might land within a range, that information can be made available." Can you please provide that information?

RESPONSE: EPA participated in a White House led interagency process providing input to the development of the United States' Nationally Determined Contribution. As noted in the NDC document, the process of developing the target included consultation with relevant departments and agencies across the federal government and reviewing a range of pathways for each sector of the economy that produces greenhouse gases. As part of this process, EPA provided qualitative information about our regulatory and voluntary programs and discussed approaches to quantitative analysis. EPA never prejudged the impact of individual rules that have not been adopted.

In addition to participation in these interagency discussions, EPA provided the White House with a pre-publication version of the U.S. Greenhouse Gas Inventory (now published with data highlights available at https://www.epa.gov/sites/production/files/2021-04/documents/us-ghg-inventory-1990-2019-data-highlights.pdf). EPA also provided the White House with a spreadsheet comparison between the GHG inventory and other publicly-available models projecting U.S. greenhouse gas emissions.

As EPA proposes new regulations to reduce pollution from stationary and mobile sources, we will be fully transparent and provide a thorough, detailed analysis of the proposal and solicit robust public comment. As a matter of course in Agency rulemakings and per relevant federal executive orders and guidance, EPA performs regulatory impact analyses to quantify, when feasible, the likely benefits and costs of certain regulatory options.

37. We do not hear enough about the bipartisan ways Congress has addressed climate – including through bills in this Committee's jurisdiction. At the end of last year, President Trump signed into law both the bipartisan American Innovation and Manufacturing (AIM) Act that would phase down hydrofluorocarbons (HFCs) and the Utilizing Significant Emissions with Innovative Technologies (USE IT) Act that would support carbon capture, utilization, and sequestration. During your testimony, I asked you if the AIM Act was still a top priority for the Agency. As you know, this bipartisan legislation was signed into law by President Trump. In response, you stated, "We can get the specific timeline. But we recognize the urgency and the importance of the legislation. We can provide you with those details." My office did not receive any details before you

signed the proposed rule on April 30, 2021. Can you commit to outreach to my office on AIM Act implementation to ensure a smooth implementation of this bipartisan law?

RESPONSE: The AIM Act contains clear timelines for the implementation of the HFC phasedown and the statutory requirement is to have a phasedown allocation and trading program in place 270 days after the bill was enacted, which will be September 23, 2021. On May 19, 2021, EPA published a proposed rule to create an HFC allowance and allocation program, which we intend to finalize by the end of September 2021. EPA is committed to outreach to congressional offices, stakeholders, and the public as we implement the AIM Act to ensure the smoothest implementation of this bipartisan law.

EPA held a number of stakeholder meetings to gather feedback while developing this proposal, including a general stakeholder meeting on February 25, 2021, with more than 200 participants, and five sector-specific workshops on March 11 and March 12. In addition, EPA held another sector workshop on April 26. EPA has also held more than 60 individual meetings with interested companies, associations, and environmental and public health organizations, as well as federal and state agencies. EPA held the virtual hearing on June 3 with more than 275 participants, and the comment period will be open through July 6, 2021. In addition, we have worked with congressional committee staff—including yours—to schedule a briefing for them on this topic.

38. In a response to my question for the record to you concerning the Kigali Amendment from your nomination hearing, you stated that you were not familiar with the relationship between the Kigali Amendment and the AIM Act.

    a. Have you have been briefed by EPA staff on this question?

RESPONSE: Yes, I have been briefed on the AIM Act, which included information on the Kigali Amendment similarities and differences.

    b. If so, what did you learn?

RESPONSE: The AIM Act provides EPA the legal framework to implement a HFC phasedown consistent with the requirements of the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer.

39. EPA has received a number of petitions from industry and environmental groups under the "Technology Transitions" provision of the AIM Act. Have you responded or made any decisions on the petitions that you have received?

RESPONSE: As outlined in the AIM Act, EPA has 30 days after receiving a petition to make the petition publicly available and 180 days to grant or deny the petition. We received our first five petitions on April 13, 2021, and within 30 days we opened a docket and posted links to the petitions on our website. We published a Notice of

Data Availability on May 25, 2021, to provide notice of the new docket where these and additional petitions will be made publicly available. Interested parties can submit relevant information related to petitions in the docket as we consider the petitions.

40. Numerous public comments were submitted to EPA's Notice of Data Availability related to non-defense related uses of HFCs that are exempted under the AIM Act. These comments highlighted large amounts of uncertainty surrounding the availability of data to accurately account for current use of HFCs, for example in metered-dosed inhalers (MDIs). EPA's own market characterization study found that the number of MDI's using HFCs ranges between 56 and 123 million per year. Such a discrepancy between the high and low-end estimates of usage complicates the ability for EPA to set an accurate baseline for the phasedown of HFCs. Do you agree with commenters on the Notice of Data Availability that there are significant discrepancies in available data that complicate setting an accurate baseline?

RESPONSE: Commenters on the NODA provided statements suggesting which sources of information were likely to be more accurate for the estimated consumption amounts of HFCs in the specialized medical-grade propellant sector. Based on these comments and additional information, EPA's updated market characterization, available in the docket for the proposed rule, narrows the ranges for the MDI application. EPA requested and will consider comments and additional information provided during the public comment period.

With regard to setting the baseline, Congress established the methodology based on historic production and consumption of HFCs. EPA has proposed to determine these values based on the total quantity of bulk HFCs entering the U.S. market (e.g., through production and import), not the number of individual products, such as MDIs, that are sold in the United States. The AIM Act directs EPA to establish HFC baselines for production and consumption as equal to the sum of:

> **1. The average annual quantity of all 18 statutorily listed HFCs produced or consumed, respectively for 2011, 2012, and 2013;**
> **2. 15 percent of the production or consumption respectively, of hydrochlorofluorocarbons (HCFCs) in 1989; and**
> **3. 0.42 percent of the production or consumption, respectively, of chlorofluorocarbons (CFCs) in 1989.**

41. Because the AIM Act and the USE IT Act contain explicit directions to EPA, will you commit to prioritize implementation of the AIM Act and USE IT Act over other climate efforts in the Office of Air and Radiation where you lack clear Congressional timelines?

RESPONSE: The AIM Act and USE IT Act include clear statutory timelines for implementation, and EPA will continue to work to meet these deadlines while also continuing to work on other climate efforts in the Office of Air and Radiation. Similarly, EPA is working to implement the USE IT Act.

42. Do you plan to include a specific line item on your Fiscal Year (FY) 2022 budget to implement the AIM Act and the USE IT Act?

RESPONSE: The FY 2022 President's Budget reprioritizes addressing climate change with the urgency the science demands. The Budget includes an increase of $1.8 billion in programs across EPA to tackle the climate crisis while also delivering environmental justice to marginalized and over-burdened communities, investing in local economies, and creating good-paying jobs. Activities related to AIM Act and USE IT Act implementation do not have a specific line item for FY 2022. For more information on AIM Act implementation, please refer to the Program Project description regarding Stratospheric Ozone: Domestic Programs at the following website: https://www.epa.gov/sites/production/files/2021-05/documents/fy-2022-congressional-justification-all-tabs.pdf.

43. The Renewable Fuel Standard (RFS) poses challenges for refiners. Several refineries have already shuttered, idled, or transitioned. With the added challenge of the pandemic, there is a concern that more will follow suit, affecting thousands of good-paying jobs. How do you plan to protect refining jobs as EPA implements the RFS?

RESPONSE: I understand the concerns you and others are raising with regard to the economic situation facing the oil refining sector, and I have heard from stakeholders directly about the challenges that the pandemic has posed to both the refining and biofuel industries. I'm committed to moving forward in a way that follows the law, follows the science, is transparent, preserves the integrity of the program, and provides certainty.

44. The Water Infrastructure Finance and Innovation Act (WIFIA) program typically operates on an approximately 100-to-1 appropriations funding multiplier, increasing its leveraging power, and making it a very successful tool for local governments to finance water infrastructure projects. A "federal project" receives a scoring of dollar-for-dollar appropriations under the Federal Credit Reform Act—far from the 100-to-1 appropriations funding multiplier. To address the confusion and rectify this scoring issue, the water infrastructure legislation passed recently by this Committee and the Senate EPW included language addressing the issue. Do you believe that just because a prospective project—otherwise entirely eligible for WIFIA funding—is near a federal project, it should automatically be effectively ineligible for participation in the WIFIA loan program?

RESPONSE: EPA is committed to implementing the WIFIA program consistent with direction provided by Congress. EPA is operating the program pursuant to the WIFIA statute and guidance developed in response to language in the Further Consolidated Appropriations Act, 2020. EPA looks forward to providing any technical assistance Congress may seek on this issue.

45. What is your plan to work with the Office of Management and Budget to ensure that these types of truly "non-federal" projects not defined as "federal project" under the WIFIA program?

RESPONSE: As noted above, EPA is committed to implementing the WIFIA program consistent with direction provided by Congress. EPA is addressing this issue, in coordination with the Office of Management and Budget (OMB) and the Department of the Treasury, consistent with the process laid out in the June 30, 2020, criteria pursuant to the Further Consolidated Appropriations Act, 2020 (85 FR 39189).

46. As of May 11, 2021, calendars for the Office of General Counsel leadership has not been publicly released as they have been for other EPA offices. Do you plan on requiring the leaders of Office of General Counsel to display their calendars on this website?

RESPONSE: It is important for all public servants to be as transparent as possible with Congress and the public as we look at information and develop decisions at EPA. As I pledged before you at my nomination hearing in February, I am committed to conducting the Agency's work in a transparent manner as we restore scientific integrity and evidence-based policymaking throughout EPA. To that end, I have put in place a process to provide a simplified version of my appointment calendar showing my meetings with the public at https://www.epa.gov/senior-leaders-calendars. This is updated on a regular basis. Pursuant to my memo on transparency issued on April 12, 2021, other senior leaders will also be sharing their simplified calendars. For example, the Acting General Counsel's simplified calendar is available at https://www.epa.gov/senior-leaders-calendars/calendar-melissa-hoffer-acting-general-counsel. EPA is in the process of onboarding the Agency's leadership into a new process that allows us to keep these regularly updated. We will be adding more calendars soon.

47. In an April 7, 2021 letter to you, I requested EPA provide calendars for the Agency's senior leaders that included the subject and participants in the calendar entries. The simplified versions of the calendars currently on the EPA website do not contain these details. Will you work to establish a process for EPA to transmit the calendars with the requested detail to Committee staff on at least a monthly basis?

RESPONSE: EPA understands the importance of Congress' need to obtain information necessary to perform its legitimate oversight functions, and the Agency is committed to working with your staff to accommodate Congress' interests. My staff provided an initial production of information responsive to your request on April 23, 2021, and they anticipate delivering additional responsive documents to your office on a rolling basis as they become available.

48. Senator Blackburn sent a letter to the Agency on February 3, 2021 regarding Senior Counselor to the Administrator Avi Garbow. In response, the EPA's Designated Agency Ethics Official stated that Mr. Garbow was appointed as a Special Government Employee

(SGE) as defined under 18 USC § 202(a) and was able to serve up to 130 days in a 365-day period.

a. Can you provide the date when Mr. Garbow's 130 days service period will end?

b. In his SGE-appointed role as Senior Counselor to the Administrator, what issues has Mr. Garbow counseled the Administrator on and was he recused from working on any issues?

c. Can you please provide a list of any other current SGE appointments and the role each appointee has within the Agency?

RESPONSE: On January 22, 2021, Mr. Garbow returned to EPA under a Special Government Employee (SGE) appointment as defined by 18 U.S.C. § 202(a). An SGE serves up to 130 days in any 365-day period but those days of service need not be consecutive. Those days need not be consecutive; any portion of a day worked counts as a full day. SGEs are not expected to work over weekends or holidays. Career federal ethics officials briefed Mr. Garbow about his obligations, noting that the federal ethics rules apply differently to SGEs than to regular government employees. As an SGE, Mr. Garbow could not work on any particular matter in which Patagonia or any of the boards on which he serves is a party or represents a party. Mr. Garbow concluded his service to EPA as a SGE on June 30, 2021. Attached is a list of SGEs as of April 2021.

Senator Inhofe:

1. Administrator Regan, there are a number of measures that we must take to eradicate the COVID-19 pandemic. Vaccinations are an important and effective measure against the virus but there are additional measures that can be utilized to reduce the spread of COVID-19, including through long-lasting disinfectants. Long-lasting disinfectants minimize the required number of regular disinfectant applications, thereby reducing the potential negative health impacts that come from over application of regular disinfectants. Allied BioScience (ABS), a biotech firm, created "SurfaceWise2", which is a continuously active antiviral surface coating that kills viruses, including SARS-CoV-2. Accordingly, ABS has submitted an application for nationwide use of the product under the standard authority laid out in Section 3 of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). If approved for use, Americans would have access to a long-lasting disinfectant that has been approved by EPA for residual efficacy of up to 30-days. When do you expect the final Section 3 approval process to be completed?
   a. Are there any steps you can take to expedite the regulatory review process?
   b. And will you please keep my staff updated on EPA's review and actions related to this application?

RESPONSE: To respond to the public's needs over this past year of the pandemic, EPA expedited review and approval of surface disinfectant products for use against SARS-CoV-2, the coronavirus that causes COVID-19, created List N, a public

listing of products expected to be effective against SARS-CoV-2, and then added over 500 products to it. Over the course of the last year, EPA reacted to unprecedented circumstances by activating its Emerging Viral Pathogens guidance, minimizing disinfectant supply chain disruptions through regulatory flexibilities, releasing new and updated scientific protocols, and providing several pathways for expedited review.

EPA is following the evolving science of the pandemic by shifting resources to the evaluation of novel products, such as those that kill airborne SARS-CoV-2. We will keep Congress informed on EPA actions, including communicating with your office, regarding Allied BioScience's application for registration of their SurfaceWise2 product.

2. Administrator Regan, the COVID-19 pandemic has caused severe economic hardship to a number of job creators, including to the refining sector in Oklahoma. In February, EPA received hundreds of comments about the need for EPA to use its authority to waive or significantly reduce the 2020 renewable volume obligation (RVO) under the RFS. I, along with Sen. Toomey, other senators and a bipartisan group of governors, respectively urged you to waive or significantly reduce the RVO. Even Growth Energy, a trade association representing ethanol producers, has admitted, "...the 2020 RFS standards would have at most a negligible effect on production or use of ethanol..." This is further evidence waiving the RVO would not harm ethanol production. With this in mind, can you explain why RVOs should continue to increase when even their purported beneficiaries question their value?
    a. How will EPA protect refining jobs as you consider implementation of the RFS?

RESPONSE: I understand the concerns you and others are raising with regard to the economic situation facing the oil refining sector, and I have heard from stakeholders directly about the challenges that the pandemic has posed to both the refining and biofuel industries. I'm committed to moving forward in a way that follows the law, follows the science, is transparent, preserves the integrity of the program, and provides certainty.

Senator Shelby:

1. As you may know, working forests are a vital part of Alabama's economy and wood energy is a critical component of what can be described as the circular forest economy. Private working forests are considered carbon sinks, meaning they reduce the net amount of CO2 in the atmosphere as they grow.

   I believe climate mitigation strategies must prioritize keeping these forests in working condition, which means supporting strong forest products markets in all sectors of the industry and also preserving well-paid rural jobs. Renewable energy is an important and valuable market for low value trees and residuals removed from private working forests and from public lands – especially for onsite generation in often remote locations. As

such, will you work with the forestry and forest products sector to ensure that this circular economy can be preserved?

a. And in particular, will you work with the forestry and forest products sector, including forestry-focused research institutions, to devise an easier way for forest owners to comply with the federal forest carbon offset programs? Currently, these programs have onerous requirements that are difficult for forest owners, especially family forest owners, to meet.

RESPONSE: While there is no federal forest carbon offset program in the United States, EPA does work closely with the U.S. Forest Service to compile forest carbon estimates as part of the national Inventory of U.S. Greenhouse Gas Emissions and Sinks. EPA has also provided technical input to external groups developing offset protocols that aim to balance rigor with implementation burden and to USDA in their development of GHG quantification tools for landowners.

Senator Wicker:

1. Currently, the Environmental Protection Agency (EPA) is seeking applications for its technical assistance program for small and rural wastewater systems. This program was authorized through legislation I introduced in 2018, the Small and Rural Community Clean Water Technical Assistance Act. The legislation was included in the America's Water Infrastructure Act (P.L. 115-270). EPA neglected to mention a key part of my legislation in its notice, which requires funding to go toward technical assistance that small treatment works find most beneficial and effective. I appreciate EPA's efforts to establish this program. However, it is important that the agency follows congressional intent and funds training that small and rural communities find most beneficial, such as on-site technical assistance. As EPA awards this funding, how will the agency ensure that the priorities of small treatment works are considered?

RESPONSE: EPA was pleased to announce in March 2021 the inaugural Request for Applications (RfA) for Training and Technical Assistance for Wastewater Treatment Works for the Prevention, Reduction, and Elimination of Pollution. The Agency's intent is to consider the priorities of small, rural, and tribal treatment works and to provide awards that support training and technical assistance that is most beneficial to these communities. Eligible applicants under this announcement are public and private nonprofit organizations that are qualified and experienced in providing on-site training and technical assistance to small publicly owned treatment works and onsite/decentralized wastewater treatment systems. In the inaugural RfA, EPA asks applicants to describe an approach for providing on-site training and technical assistance. EPA also identifies specific criteria by which to evaluate applications. For example, EPA will evaluate applications on the ability to tailor the training and technical assistance techniques and resources to address the specific needs of the target audience, on the approach to effectively reach out to facilities, and on the use of innovative techniques. EPA also will evaluate

applications on the process to consult with and stay in contact with state, tribal, and territorial authorities, as these authorities have information and experience on the needs of their small treatment works. EPA also consulted via letter with states regarding what technical assistance approaches their small publicly owned treatment works find to be most beneficial and effective.

Senator Sullivan:

1. The City of Ketchikan water system serves approximately 8,050 people. The city utility operates under Filtration Avoidance Criteria defined in 40 CFR 141.71. One of the requirements for filtration avoidance is that the fecal coliform concentration must be equal to or less than 20/100 ml in a minimum of 90% of samples collected for the six previous months. In October and November 2019, the rolling six-month average of samples was 89% and 88%, respectively. The Alaska Department of Environmental Conservation (ADEC) subsequently notified the city utility that it had failed to comply with the filtration avoidance criteria and had eighteen months to install water filtration, which is estimated will cost in excess of $70 million and add $2 to $3 million in additional annual operating costs.

   The Safe Drinking Water Act 42 U.S.C. § 300g-1(b)(7)(C)(v) provides an alternative compliance framework for some unfiltered surface water systems known as a Limited Alternative to Filtration (LAF). On March 9, 2020, Ketchikan requested ADEC evaluate its eligibility for the LAF provision. Due to the high cost and other challenges of constructing a filtration plant in southeast Alaska, Ketchikan is pursuing a Compliance Order by Consent (COBC) with EPA, which will detail what Ketchikan must do to qualify as a LAF system, including demonstrating: 1) The system has "uninhabited, undeveloped watersheds in consolidated ownership," 2) the system has control over both "access to, and activities in, those watersheds," and 3) The system's source water quality and the alternative treatment requirements established by the state must ensure greater removal or inactivation efficiencies of pathogens than would otherwise result from the treatment requirements stipulated by regulations.

   Ketchikan generally meets these requirements, however, its water is drawn from uninhabited, undeveloped watersheds, but not under consolidated ownership. The city utility has demonstrated an ability to control human activity and access to these watersheds supplying raw water to the utility's treatment facilities. Since Ketchikan does not own the lands within which the watersheds are located (they are U.S. Forest Service Bureau of Land Management lands), there is concern whether they can qualify for Limited Alternative to Filtration designation as the city does not have "consolidated ownership" of the lands that make up the watersheds. However, EPA also has precedent for approving a LAF in a similar situation. In the past EPA signed a Memorandum of Agreement with the Washington State Department of Health that granted the agency's first and only Limited Alternative to Filtration designation to the Seattle Cedar River Supply. The language within EPA's MOU explicitly states that the term "consolidated ownership" was never intended at the time of the 1996 SWDA amendments to "imply that there must be only one owner of the watershed ...."

a. When these factors are taken in their totality, can EPA assure Ketchikan that it does in fact have "consolidated ownership" of the watersheds and that the City is in a position to pursue a Limited Alternative to Filtration (LAF) designation through a Compliance Order by Consent (COBC) with the Alaska Department of Environmental Conservation?
b. Will you commit to working with me, EPA Region 10, and the City of Ketchikan to resolve this issue?

RESPONSE: Thank you for highlighting this important issue. EPA understands that at the request of the Alaska Department of Environmental Conservation (ADEC), EPA Region 10 and EPA Headquarters are in discussions with ADEC about the Limited Alternative to Filtration (LAF) provision in the 1996 Safe Drinking Water Act amendments. EPA also understands that both ADEC and EPA recognize that it will take time to assemble the request for ADEC's review and decision, and EPA concurrence for a LAF designation for Ketchikan. EPA will remain engaged and will continue to support ADEC's discussion of options with Ketchikan. EPA is committed to working with you, ADEC, and Ketchikan on this important issue.

Special Government Employees (SGE) employed by EPA in April 2021

Name
ANDERSON, HENRY A.
ANDREWS, RODNEY J.
BENNETT, DEBORAH H.
BLANZ, ROBERT E.
BORMAN, DAVID SCOTT
BRADY, JOHN LEE
BREWER, TODD F.
BURKEN, JOEL G.
CHAMBERS, JANICE E.
CHRISTY, JOHN R.
COHEN, SAMUEL M.
COSTA, MAX NMN
COX, LOUIS A. JR.
CRAIG, BRUCE A.
CULLEN, ALISON C.
DANIELS, LISA
DEVLIN, ROBERT B.
FELTER, SUSAN P
FOX, JOHN F.
FRAMPTON, MARK W.
GARBOW, AVI S.
GARDELLA, JOSEPH A.
GRAHAM, JOHN D.
GUCKENHEIMER, JOHN M.
HOGAN, KAREN A.
INES, AMOR VM
KENDALL, RONALD J.
KENSKI, DONNA M.
KHUMAN, JAG
KIM, CHONG S.
KLEINDIENST, TADEUSZ E.
LANDIS, WAYNE G.
LAWS, SUSAN C.
LEUTNER, FREDERICK D.
LUO, YUZHOU
MACDONELL, MARGARET M.
MARTIN, CLYDE F.
MCNAIR, LINDSAY A.
MUNDT, KENNETH A.
NELSON, DANIEL K
NOVAK, JEFFREY M.
PHALEN, ROBERT F.

POIROT, RICHARD L.
POTTER, SCOTT A.
POWELL, JOANN B.
PRESTON, ROBERT J.
PRICE, PAUL S.
ROSI, EMMA J.
SEELEY, MARGUERITE R.
SETZER, RHYNE W. JR
SHERMAN, MICHAEL P.
SMITH, ANNE E.
SMITH, RICHARD L.
STRASSLER, ERIC DAVID
SULLIVAN, LAWRENCE D.
SUTER, GLENN W. II
SWACKHAMER, DEBORAH L
THEIS, THOMAS L.
ULSH, BRANT A.
VAN DER MENSBRUGGHE, DOMI
VAN DER VAART, DONALD R.
VOLLMER-SANDERS, CARRIE L
WAGNER, KEVIN L.
WHITE, KIMBERLY W.
WILLIAMS, RICHARD A.
YOUNG, SIDNEY S.
ZWIERNIK, MATTHEW J.

Senator CARPER. Administrator Regan, thank you very much for those words, and again, for your presence today.

Senator Capito, would you like to lead us off, please?

Senator CAPITO. Sure, thank you.

And thank you for your statement, and I will get right to it.

Last week, the Administration pledged to reduce greenhouse gas emissions by 50 percent to 52 percent from 2005 levels by 2030 as part of an international climate summit organized by the President. According to a White House fact sheet, the National Climate Task Force developed those figures from "a detailed bottom up analysis, standards incentives programs, and support for innovation were all weighed in the analysis."

I know that you are a member of that task force. So I am interested to know more about what EPA's role was in developing this, which EPA regulations did they rely on to get to this admissions pledge. And I also would like to know if it is public information we could see how these figures were arrived at.

Mr. REGAN. Thank you for the question, Senator. I believe and know that EPA is central to the NDC number that was developed. What we did as part of our contribution, I would like to acknowledge that the NDC number is a governmentwide approach.

Senator CAPITO. Right.

Mr. REGAN. Not purely from regulation, but looking at all of the agencies' contributions through regulatory and non-regulatory.

Our role will be critical. I think we projected what we can accomplish and do through our non-regulatory and regulatory programs. So when we look at what we are planning to do with tailpipe emissions standards on our vehicles, when we look at what we plan to do on regulations that focus on emission reductions, and when we look at what we plan to do in concert with the Clean Power Plan, those are just a few of the regulatory actions that were considered in the NDC.

Along with voluntary programs that we have, our Energy Star program, looking at our partnerships with agriculture and all the work that they are doing on a non-regulatory level.

So we attempted to quantify EPA's role and its contribution to meeting that NDC. We believe that it is a good target.

Senator CAPITO. Are those figures, you have mentioned quite a few, are those available for public view to see what you estimated the emissions reduction targets would be under those programs?

Mr. REGAN. I think the information that we generated that focuses on conceptually where these regulations might land within a range, that information can be made available.

Senator CAPITO. Thank you. I would like to see that.

Last year, the President signed two pieces of legislation in the Diesel Emissions Reduction Act, and also the USEIT Act, which helps EPA to support carbon capture utilization and sequestration research and permitting. I am wondering, and this was touted at the time, certainly, the AIM Act, which is, I think, the Diesel Reduction Act—no, I am sorry. The American Innovation and Manufacturing Act, is another one of these, your HFCs. Your HFCs, our HFCs. It is perhaps the most significant climate legislation.

Your budget and your testimony do not mention the USEIT Act or the AIM Act. Is this still EPA top priority, and are you going

to begin the regulatory framework for this? This is obviously something we came together on, and it is important to all of our members.

Mr. REGAN. Absolutely. Absolutely, it goes not unnoticed that the AIM Act is one of the most important pieces of legislation to combat climate change. I am happy to report that we are excited about that bipartisan piece of legislation, and we are on track, we are on track for developing the regulations and the implementation associated with that.

Senator CAPITO. Knowing that regulations take a long time to roll out, are we talking years, here? Six months? How do you quantify that?

Mr. REGAN. I would have to take a look at exactly what the timeframe is. I can tell you it is a priority. I just had a briefing and a discussion this week. So we can get the specific timeline.

But we recognize the urgency and the importance of the legislation. We can provide you with those details.

Senator CAPITO. OK, let's talk PFAS here for just a minute. You mentioned it, and certainly I mentioned it as well. While EPA has made a lot of progress under the PFAS action plan, there is obviously a lot of work left to do. As you and I have talked, we need to make sure we have the sound science here.

You are requesting $75 million focused on PFAS studies and research. Could you give a few more details?

Also, that drinking water standard is where I have a great deal of interest. I want to know where you all are on that and where you think you might be able to give us something more definitive in your action plan.

Mr. REGAN. Yes, I will say that, and obviously for the $75 million there would be a lot more detail in the full budget to come. But we are moving full steam ahead.

Setting that drinking water standard is very important to us. We are moving ahead with that. I think we had to make up for some lost time to ensure we had the best science informing that drinking water standard and looking at our statutory authority.

In addition to setting that drinking water standard, we are also looking at the science behind designating PFAS as a hazardous substance. We want to be able to look across multiple EPA programs.

So we are having a look at PFAS, and the applicability of CRCLA. We are looking at PFAS as it relates to a drinking water standard. And we are also looking at, I have actually set up a PFAS council within the agency to be sure that as we look at our Superfund-Brownfields approach, CRCLA approach, rather, and looking at our drinking water approach, that we are looking at PFAS in its totality, that we recognize it is a pervasive chemical, it is impacting many communities.

So in addition to the regulations, we also have some remediation and cleanup that we know needs to be done and needs to be done fairly quickly. So we are taking a comprehensive look at it.

Senator CAPITO. Good, thank you.

A quick question. You allude to a lot of research, additional research dollars. I am curious to know, those research availabilities, they are spread all over the country, I would imagine, to different

higher education institutions. It is not done just within the EPA. Is that a correct assumption on my part?

Mr. REGAN. It is. Many of these chemical compounds, there is just not a lot known about the health impacts. So when we think about setting regulations, we want to be sure that we set the regulations at the appropriate level. We don't want to miss that mark.

So the more we can convene with our academic institutions, the CDC and others, to be sure that we have the right amount of science and health studies to set these regulations, I think the better off it is for all of us.

Senator CAPITO. So I would encourage you, if you do get the available funds, and you are expanding your research, to maybe go outside what would be your typical universities or colleges that are known as the biggies, I will call them, the big guys, to look at West Virginia University or Marshall University, the universities all throughout this country that have a great deal of bandwidth to be able to do these kinds of things, looking for research opportunities. Particularly in our State, having been the ones that are sort of at the tip of the spear of a lot of these regulations, I think it would help us become part of that solution.

So I would encourage you at EPA to look in that direction.

Thank you.

Mr. REGAN. Thank you.

Senator CARPER. In the Navy, when we are wanting somebody to take home a particular message, whoever is instructing a class or whatever, they would stomp their foot, and we would be reminded to take notes. That was probably a foot stomper right there.

Thanks for those questions and responses.

We have on deck, Senator Cardin, I believe, is next by Webex, followed by Senator Inhofe. Senator Markey is next on Webex and Senator Boozman after that.

Senator Cardin, you are up, and then Senator Inhofe, on deck.

Senator CARDIN. Mr. Chairman, thank you very much.

Administrator Regan, thank you for your leadership at EPA. I want you to know, many of us are very supportive of President Biden's commitment in regard to the Climate Summit and what America will do. We are going to be a global leader because we recognize this is a global problem, and we have to lead by example. So there is strong support for the initiatives of the Administration.

I want to follow up on a conversation we had a little bit earlier today in regard to clean water and the availability of clean water and the environmental justice issues, then climate resiliency and water infrastructure. We are going to give you some additional help today in a bipartisan bill that we expect to pass on the floor in regard to clean water, drinking water, and wastewater.

I want to deal with the issue that, in dealing with resiliency, there is a cost issue to the local agencies. The ability to deal with this by the ratepayers presents significant affordability challenges.

So in the legislation we are considering on the floor, there is a pilot program that was offered by Senator Wicker and myself that will allow you to establish pilot programs to deal with the affordability issue. I know you have other tools available in your tool kit to deal with this.

I really want to hear how this budget that is being submitted will help us deal not only with clean water, safe drinking water and wastewater, but how it will deal with the affordability. What resources can be made available to deal with the community challenges on the affordability of water?

Mr. REGAN. Senator, thank you for that question. It is an excellent question. I am so delighted that there is a bipartisan bill coming from this body that demonstrates that this is a bipartisan effort that is plaguing many communities across the country.

The good news is that EPA has experience in this area with our water infrastructure grants and loan programs. So what we want to do is infuse capital into an infrastructure program that is tried and true, and that we have invested billions of dollars in over the years and helped to spur economic prosperity through those lenses.

I think there are low interest and no interest loan programs as well as our grant programs. We have targeted criteria for those recipients who are best positioned to leverage these resources, whether it can be through a loan program that they can afford to repay or grant programs, where we have some of the challenges that you have raised.

Water affordability is very important to this agency, being led out of OW by our Principal Deputy Radhika Fox. She brings a lot of experience on water affordability.

We recognize in the moneys that we are asking for, we are asking for these resources that can focus on the infrastructure in general, the water quality aspects of them. But we have water affordability built into the funds that we are trying to distribute to ensure that it is not only good quality drinking water, but that our public can afford it.

By the way, we are also building in resiliency, not only to climate change impacts, but to cyber threats as well. We estimate that there is about $743 billion worth of water infrastructure needs across this country. I know 18 to 27 alone in my home State of North Carolina.

So the resources that we are requesting in the 2022 budget are a beginning for us. We are proud to see the $111 billion the President has proposed in the American Jobs Plan. It is going to take these resources matched with public and private investments to catch us up to be where we need to be.

Senator CARDIN. I support those efforts.

Let me give you one other bipartisan initiative here, and that is the Chesapeake Bay. I have worked very closely with Senator Capito and others on our Committee. I know that your budget request requests additional funds for the agency. I hope that some of those resources will be used to expand the Federal partnership with the Chesapeake Bay, fill the position of the Chesapeake Bay czar, and just up the game with the Federal partnership in the Chesapeake Bay.

Mr. REGAN. Absolutely. We have requested resources to do exactly what you said, the way you said it, up the game and focus on the Chesapeake Bay, which is a national treasure, both ecologically and economically. So we are supportive in that area.

Senator CARDIN. Thank you.

Thank you, Mr. Chairman.

Senator CARPER. Thank you, Senator Cardin. Thanks very much to you and the team that you lead, your staff, for all the good work that you have done in consultation and cooperation with Senator Capito and myself, Senator Duckworth, and others on our water legislation. Before the full Senate tomorrow, thank you.

Next is Senator Inhofe.

Senator INHOFE. Thank you, Mr. Chairman.

Mr. Regan, confession is good for the soul. I confess that I came from the House to the Senate in 1994, and during that time, I can't think of any person who has possessed a position like yours that I have been more fond of but had to vote against than you.

[Laughter.]

Senator INHOFE. The reason for that was, I look at all these things that we are, they are attempting to do in this Administration. The job killing, I have a hard time figuring out why we are doing what we are doing.

Why would we be encumbered here in the United States with regulations that are going to put people out of business, cause industries to leave the United States, and yet the largest polluter is China? I mean, China, right now, is building coal fired power plants at a rate outpacing the rest of the world combined.

In 2020, China brought more than three times what was brought online elsewhere. Last year, China generated 53 percent of the world's coal fired power plants. We generated 19 percent.

Now, I guess I would start off with, how do you justify that?

Mr. REGAN. Senator, thank you for the question.

Senator INHOFE. Are you sure?

[Laughter.]

Mr. REGAN. I know it is on your mind and on the minds of others. I think what we saw last week was the President rallying the world to begin to address this issue, and China was at the table.

I think with the American Jobs Plan and the direction we are headed, it is not solely an opportunity just to mitigate against climate impact, it is an awesome opportunity for us to lead in technological advancements and create jobs. We know that the markets are trending directionally in this way.

I believe that is why the U.S. Chamber of Commerce and organizations like the Petroleum Institute are on board with looking at regulations that really pursue deep cuts in methane. The reality is that with CCS, with methane technologies and others, America is poised to cut deeply these greenhouse gases, but also deploy these technologies internationally.

So we have an awesome opportunity to grab onto this, and not only create jobs domestically and ride the wave of where the market is going, but export these technologies as well, to get these deep emission reductions that we need to get.

Senator INHOFE. Under this agreement, and this is kind of reliving what happened in the past, China gets a free ride. China doesn't have to—they can continue for their growth and those generations of energy for 15 years.

Then you have India. In India, I assume, I haven't heard anything recently, since this has re-emerged, initially, in the initial Paris Accord, India was demanding billions and billions of dollars. I was looking for that figure, and I can't find it now.

But anyway, they were, and so yes, they join in. Well, why not? I can understand that.

In the case of China, I would say the greatest threat that we have with China is that we have to comply. Have you done any kind of a study that, what EPA regulations will be needed in order to meet President Biden's new Paris climate commitment? He has made a commitment, what we are going to do in the United States. What is going to be the cost of that commitment?

Mr. REGAN. I think the studies that we have done, and what we are actually doing in terms of meeting that commitment, is we are in constant communication, right now engaging with the automobile industry and the unions. We are engaging with many fossil fuel companies.

I was on a call with EEI membership just 2 weeks ago, CEOs from the power plant sector, discussing exactly what we need to do to structure a process where we deploy the right technologies, keep these jobs in America, and get the jump on reducing greenhouse gases and methane.

Senator INHOFE. Yes, but you know, Mr. Regan, since they have to meet these requirements, have we analyzed to see what the cost is going to be, and that would be incurred by industries here in the United States? Now, those industries, some of them, may take the position that, well, we can go to China, we can make more money and move our operation to China. That is the concern that is out there.

Let me ask in a different way. Last week I introduced legislation that would ensure that China is held to the same emissions reductions commitment as the United States. Now, isn't that common sense?

Mr. REGAN. Senator, I just see America as a leader. The President's Jobs Plan isn't really following China, it is really looking at where the markets are driving and how we really harness the technological advancements that we are seeing.

We are talking about CCS, we are talking about these deep methane cuts, we are looking at electric vehicles and talking with the automobile industry that believes they can get there in a timeframe where we can have all those jobs homegrown.

I think this is a huge opportunity, and the President thinks this is a huge opportunity for a governmentwide approach to look at how we leverage resources to build American jobs, leverage technology in the market, and by the way, get some really deep emission reductions from methane and CO_2.

Senator INHOFE. OK. Have you done anything to determine what EPA regulations are going to be needed to meet the requirements?

Mr. REGAN. What we are doing now is we have provided sort of a range of how we think we play in that NDC number. As we develop our regulations, we will do the cost-benefit analysis, we will look at the cost of technologies.

To answer your question directly, as we look at these regulations, there will be a number of technologies, timelines, and paths that we will be discussing with those who are regulated. It will be that combination of things that will ultimately yield a regulation that determines that final number.

It is a work in process.

Senator INHOFE. It is a work in process, but you don't know, and I am not—I don't think there is any way you could know at this point, what it is going to cost to comply with those regulations. They are going to have to do things that is going to be more expensive to operate. I think we all understand that.

My concern is that China will not have to do that. There are many industries here in the United States that will actually benefit from more regulations in the United States because all they have to do is move to China, and there won't be any regulations.

Senator CARPER. Senator Inhofe, I hate to do this, but you are about 3 minutes over.

Senator INHOFE. Yes, I know.

Senator CARPER. So I am going to ask you to hold it there, and if you have further questions, we may have some time at the end. If not, I know the Administrator will be happy to——

Senator INHOFE. Yes, the reason I went over a little bit, Mr. Chairman, is that I can't stay for longer. And I wanted to be sure to get the point across that some things could happen to actually benefit some of our industries, encouraging them to leave and go to China and actually perform better.

But we are the big loser here in the United States. I have run companies, I did that for a living before I got here.

Thank you very much.

Senator CARPER. Thank you.

Next, Senator Markey, on Webex.

Senator Markey, welcome.

Senator MARKEY. Thank you.

Mr. Administrator, talk a little bit about methane, please, and what we can do in order to dramatically reduce the amount of methane which is coming out of the oil and gas sector.

Again, just very clearly, that it is 80 times more powerful as a pollutant than CO_2 in terms of increasing the greenhouse effect, while simultaneously, especially in the oil and gas sector, it is the easiest thing to do in order to just eliminate that methane from going up into the atmosphere.

Can you talk a little bit about that, and what the plans at the EPA will be to deal with that issue?

Mr. REGAN. Thank you for that question, Senator. Yes, methane is a potent, very potent greenhouse gas. We have been laser focused on this topic from day one, as I mentioned in my previous answer. We have been having conversations about how we best regulate methane emissions. The President has charged us to propose a rule on methane regulations this September.

We know that there are a great deal of technologies, and the application of those technologies that make sense from a cost competitive standpoint as well as an opportunity to demonstrate in this country how we can reduce methane emissions while looking forward to exporting and leveraging those technologies in other countries.

We are having conversations with the industry; we are having conversations with our internal technical experts. We are being driven by the science. We believe that there is a good convergence of what the science calls for and what the market can tolerate.

Senator MARKEY. I agree with you, 100 percent. I just think this is something that is relatively easy for the industry to deal with, but again, it is going to require strong rules that are put on the books.

With regard to the tailpipe emissions standards, or another way of saying that, just increasing the amount of—the efficiency of all the vehicles which we drive in our country. In Massachusetts, we work along with California, in order to set the highest possible standards. What is your goal on that?

Mr. REGAN. You might have seen earlier this week, we are revisiting the California waiver situation. I think we have taken step one of two steps to do what I believe we should be doing, which is to respect the statutory authority and the opportunity for States to lead. California is leading in that regard.

In concert with that, in mid-July we will be looking at a proposed rulemaking that looks at the reduction in tailpipe emissions that we believe we need to achieve for vehicles between now and 2026. Following that, we will have another bite at the apple when we look at vehicles from 2026 and beyond.

I think we are on pace to do some amazing things, and by the way, stay in pace with where many in the automobile industry have pledged to go on electric vehicles and the market demand for those vehicles.

Senator MARKEY. Exactly. When General Motors says they plan on not making any additional internal combustion engines after 2035, well, that just sets a standard that if we codify it and put it in the books, we have a real chance then to the whole industry follow that leadership.

On the question of environmental justice, Congresswoman Cori Bush and I have introduced an Environmental Justice Mapping and Data Collection Act that we can make a law in the country that ensures that we actually identify all those communities in the United States that have been adversely affected by environmental injustice over the years.

Could you elaborate, again, on what the Biden administration's plan is in terms of focusing on those communities? How helpful would an environmental justice mapping bill be to help you to do that job?

Mr. REGAN. Thank you for that question, Senator. I would love to learn a little bit more about that legislation. I believe that it would be very complementary and actually help accentuate many of the things that we are attempting to do at EPA.

We have mapping tools, and we have data and information. But we need more. We can always do more. What we are seeing in this 2022 budget request, and also in the American Jobs Plan, it acknowledges that there are significant resources required to pay attention to past transgressions in terms of those who have been disproportionately impacted by pollution. We need to infuse environmental justice and equity into our rulemaking, into our policies, into our grant making. There is so much work that needs to be done.

So I look forward to learning more about the legislation and the complementary aspects of that.

Senator MARKEY. Would you consider elevating the Office of Environmental Justice to a standalone office, to give it more authority, more autonomy in its decisionmaking?

Mr. REGAN. Yes. I am in the process now of identifying an environmental justice advisor to come in and to do just that, to aggregate all of the environmental justice and equity work within the agency under one roof. Not just environmental justice and equity, but also civil rights.

So what we are doing is, we are looking at unifying those efforts to be sure that they get the level of attention that they should but that they are integrated across all of the offices at the Environmental Protection Agency.

Senator MARKEY. Great. It sounds like the kind of leadership our country needs. Thank you.

And thank you, Mr. Chairman.

Senator CARPER. You are quite welcome.

We have been joined by Senator Whitehouse.

Welcome, Sheldon.

I think next to join us by Webex is Senator Duckworth.

Senator DUCKWORTH. Thank you, Mr. Chairman.

Administrator Regan, thank you for being here today. I very much am glad to be able to speak to you.

The EPA Office of Inspector General recently published a pair of reports that revealed the Trump administration's political appointees improperly interfered with the work of dedicated civil servants in the EPA Region 5 office located in Chicago. I originally requested these IG investigations after receiving troubling information, but even I was shocked by the scope of the abuse that investigators uncovered. This includes senior political appointees betraying their oath of office by instructing Region 5 staff to not monitor toxic emissions, hide reporting, suppress staff comments, break with standard protocols.

I was particularly outraged to learn that the Trump administration delayed communicating potential health risks to Illinois residents who lived near ethylene oxide emitting facilities, even going so far as to edit Region 5's Web page to hide emissions data from my constituents.

The EPA OIG also discovered that senior political appointees in the Office of Air and Radiation issued instructions that hindered Region 5's ability to effectively address ethylene oxide emissions.

Ethylene oxide is a carcinogen that can cause lymphoid and breast cancer. Even for the Trump administration, the behavior uncovered by the IG represents a shocking dereliction of duty that places the well being of corporate polluters ahead of the health of Illinois families.

Fortunately, the Biden administration is following through on its commitment to support EPA's dedicated work force. Administrator Regan, I am confident that under your leadership, Region 5 will be empowered to carry out its mission with integrity and urgency.

Will you commit to working with me to prioritize the appointment of an excellent, permanent leader of EPA's Region 5 office, and implementing the OIG recommendations to prevent the types of abuses that took place over the past 4 years from ever happening again?

Mr. REGAN. Thank you for that question. It is so disturbing to see the level of political interference and the lack of scientific integrity that took place over the past couple of years. I can commit to you, as a matter of fact, I had a meeting just this week with our Inspector General to talk through this very issue. They, rightfully so, are making sure and holding EPA's feet to the fire that we do things the right way moving forward.

We are enjoying developing our relationship with the IG and trying to right these wrongs. We are going to do our best to do it as expeditiously as possible.

I will commit to working with you on leadership in Region 5. I will commit to you and work with you on not only this issue but many of the environmental justice clean air and clean water issues that you are doing such a great job in championing.

Senator DUCKWORTH. Thank you. I am looking forward to that.

I do want to touch on environmental justice issues. As one of the co-founders of the Senate's first ever Environmental Justice Caucus, along with Senator Carper, I am committed to working with you to strengthen our tools to achieve restorative justice for long neglected communities. Senator Booker is working with me on this as well.

I think critical in this effort to enhance environmental justice is to make sure we enhance our environmental justice mapping capabilities, so that EPA is able to integrate nationally consistent data and environmental and demographic indicators in maps and reports. Such a comprehensive data base will inform and improve development decisions, grant awards, community awareness, all of that.

Do you agree with me that our efforts to build back better would be dramatically enhanced with the help of an effective, accurate, and continuously updated Federal environmental justice screening tool? Will you work with me to achieve this goal in the coming months?

Mr. REGAN. We absolutely believe that with more data we can have better performance. I do look forward to working with you on that, learning more about that legislation. But more importantly, my agency, with the request of the 2022 resources and the resources request in the American Jobs Plan, being able to partner with you in a very thoughtful and careful way and provide all of the technical expertise that you all need to be successful in that piece of legislation.

Senator DUCKWORTH. Thank you. Just to close, I have a little bit of time left, could you explain how passing the Drinking Water and Wastewater Infrastructure Act, along with implementing the American Jobs Plan, would put our Nation on a critical path toward eliminating lead service lines and updating vital sewage systems across the Nation?

Mr. REGAN. Absolutely. These are critical investments. EPA's estimate is this country has about $743 billion worth of wastewater and infrastructure needs as it relates to water quality. We know that lead is not only harmful to everyone, but significantly harmful to our children, reducing IQ, ability to pay attention, and other serious issues.

With the legislation that you have championed in a bipartisan fashion, or are championing, and with the 2022 budget request at EPA, in addition to the American Jobs Plan that is led by the President, we are beginning to take a look at how we really begin to spur job creation focused on infrastructure improvement, to improve water quality for every single person in this country, while also protecting and mitigating from climate change impacts and cyber security threats.

There are so many wins in this equation I cannot see why we would not pursue it in the fashion that we are collectively.

Senator DUCKWORTH. Thank you so much, Mr. Administrator.

I yield back, Mr. Chairman.

Senator CARPER. Senator Capito, who do you think should go next? Senator Whitehouse, since he is here live and in person?

Senator CAPITO. He is a little sketchy, but we will go with him. [Laughter.]

Senator CARPER. All right, Sheldon, you are recognized. Please, go ahead.

Senator WHITEHOUSE. Welcome, Administrator. It is wonderfully good to see you.

The Trump administration over and over again failed to follow science and tried to replace people who understood science with people who were shills for polluting industries. You have announced that you are planning on investigating the scope of that problem within EPA. You have already replaced some of the more egregious appointments whose original appointment was not consistent with the law. I congratulate you on that.

What can you tell me about the status of the EPA internal investigation into meddling with the science on which your agency is supposed to depend?

Mr. REGAN. Thank you for that question. A couple of things. I think we are taking a careful look at what the IG reports are revealing to us, which are alarming. I am listening to the agency experts. I know many have cast the SAB and the CASAC replacements as being political, but it is the exact opposite.

What I did was sought the expertise of the career scientists and the career staff to better assess who should be in these seats advising the agency. What we determined, as you stated, was the previous Administration followed a process that was unlike any process of any previous Administration, both Democrat and Republican. What it did was it soiled the process in itself.

So we hit the reset button. What we are aiming to do is invite those who previously served and those new individuals who want to serve to reapply and provide the best scientific experience to us.

While we are doing that, we are also following the advice of our science and doing a complete review of many of the regulations that were put forward in the previous Administration, and doing a full accounting. That was directed to us by the President, and that has been my goal, to take a look at all the regulations that lacked the scientific integrity or the legal acumen. Where we see that lacking, we are going to revise those regulations.

Senator WHITEHOUSE. Do you think that this conduct under the Trump administration was a kind of mass coincidence of some kind?

Mr. REGAN. I think that the previous Administration made poor decisions that lacked scientific integrity and lacked transparency.

Senator WHITEHOUSE. Do you think there was a reason for it?

Mr. REGAN. I don't pretend to know what the intentions were of those individuals. I have not spoken with them. What we have chosen to do is focus on where things have been done incorrectly or lack that scientific integrity or legal integrity. We are righting those wrongs.

Senator WHITEHOUSE. If it turns out that a lot of these examples were driven by the same force, were interconnected in some way, would that be worth EPA knowing? Or are you simply going to treat this as if this was just some kind of peculiar mass allergy to science that had no impetus behind it, no force behind it, no purpose behind it?

Mr. REGAN. I think as our staff reviews, especially our general counsel, reviews the actions that were taken, we are taking a look at what actually occurred, what the motivations were, and based on recommendations that I will get from my general counsel, that we will get from GAO, that we will get from the Inspector General, we will govern ourselves accordingly with the evidence as it is presented.

Senator WHITEHOUSE. Well, the great questions are always who, what, where, when, and why. I urge you not to overlook the why.

At the same time, the White House has announced a task force on scientific integrity with a similar responsibility, but beyond EPA, to reach across agencies of Government and ferret out examples where the science was deliberately overlooked or ignored, or where special interests got access to the process, so that they could put their honchos in instead of people who actually understood the science and were willing to act on it.

How is that going? Do you have any visibility into that process? I assume you are contributing to it in some way as one of the agencies of Government. What can you tell us about how well that is going?

Mr. REGAN. I can say that we will be contributing to that process. We are having these conversations. EPA has never and will not act in isolation. Many of the decisions that we make not only impact our stakeholders, but impact our sister agencies as well.

So to your point, the wisdom behind it is a governmentwide approach. We are going to be a central player in that. We believe that what we are uncovering will inform that process, and what that process uncovers will inform ours as well.

Senator WHITEHOUSE. I will conclude by observing that if at the end of the day, nobody understands the cause of all of this, you haven't done your jobs.

My time is up.

Senator CARPER. Senator Whitehouse, thank you for being here, and for those questions.

I notice Senator Stabenow may be ready to join us on Webex.

Senator Stabenow, are you there?

Senator STABENOW. I am, Mr. Chairman. I have had the opportunity to listen for the whole hearing so far, and I want to congratulate you and our Ranking Member again on an excellent hearing.

Administrator Regan, it is always wonderful to have an opportunity to talk with you.

There are so many things that you will receive that affect Michigan that I care about deeply. I will limit my questions today, but I first have to say that I am very excited about what our American automobile industry is doing to really lean in aggressively, tons of billions of dollars in investments. As you have indicated, we all have an opportunity to be partners with them in doing something very, very significant. So I look forward to continuing to focus on those issues for sure.

I want to follow up on something you and I have talked about privately. We are surrounded by water in Michigan, of course. In fact, the Great Lakes are warming faster than the oceans, which is incredibly concerning to all of us. We are seeing real world economic impacts right now of what is actually happening to damage the shoreline and buildings, homes, and a whole range of things.

So it is critically important that we strongly fund the Great Lakes Restoration Initiative, GLRI. Since 2010, when I authored it, we have had $2.8 billion for projects throughout the Great Lakes region. Every dollar we put into the GLRI actually delivers $3 in economic return. It is a real winner.

In early January, we passed the new GLRI, which was led by Senator Portman and myself and Senator Tammy Duckworth and Senator Braun from the Committee. Under the bill, we have increased the authorization for funding from $300 million to $375 million in this fiscal year.

I know you haven't yet released the requested funding. We are not sure what is in there. But I am just strongly encouraging you, we certainly hope that the $375 million will be in this year's budget. I don't know if you want to give us a preview right now, but we certainly think it is incredibly important that those resources be there.

Mr. REGAN. I can tell you that we agree with you that the resources should be there. We will be able to give you the full details of just how many resources are there. But we support the resource request.

Senator STABENOW. Thank you so much. Let me now turn to something else related to water that I know you have a lot of experience with, and other colleagues have been talking about today. That is what is happening on PFAS.

Even though Michigan has established its own drinking and groundwater standards for numerous PFAS, and I think we are one of the few in the country to really do that, the Department of Defense has been a challenge to work with when addressing PFAS found on a legacy basis, like Wurtsmith in northern Michigan.

So as the EPA explores new drinking water standards and a hazardous designation under CRCLA, how will the EPA work with the Pentagon to accelerate cleanup and remediation at decommissioned bases?

Mr. REGAN. To answer your question, we will work directly with DOD. But for scheduling issues, Secretary Austin and I were planning to sit together with our teams Monday before last to tackle this issue for the first time in a scheduled meeting. But he and I have talked about how we plan to tackle this issue together.

So we know it is a very important issue. I know first hand, coming from North Carolina, and dealing directly with the PFAS issue in North Carolina being also one of the most military friendly States in the country, how important this opportunity is.

So I can commit to you that Secretary Austin and I have already had some outreach on this topic, and plan to look at ways that we can work together as we look at the drinking water standard, as we look at the hazardous designation, and as we collectively look at remediation and cleanup all across the country.

Senator STABENOW. Great. Really important. I am glad to hear you are having those conversations, and I hope it will really result in some much quicker action, not only in Michigan, but I know for colleagues across the country.

One final question. I first want to thank you for the EPA's decision on February 22nd to support the 2020 decision of the U.S. Court of Appeals for the 10th Circuit, which found that a number of small refinery exemptions approved by the previous Administration were inappropriately issued. I wonder if you can tell us what additional actions the EPA can take this year, and just as one example, how can EPA address the backlog of pathways that qualify various feedstocks for biofuel used to fuel vehicles and in the production of electricity for EVs?

Mr. REGAN. The position that we have taken is we believe that the 10th Circuit's reading of the law is the correct reading. We know that this issue will be or is before the Supreme Court. So the agency is awaiting the ultimate decision of the Supreme Court, and we will govern ourselves accordingly and follow the law.

As it relates to volumes, we know that there is a backlog in establishing the volumes for the years 2019, 2020. And we have to set volumes for 2021 and 2022.

We are working on that backlog. There is a lot of time that we have to make up. But we are focused on ensuring that the intent of the RFS is met and that EPA does its part.

Senator STABENOW. Thank you so much.

Thank you, Mr. Chairman.

Senator CARPER. Thank you, Senator Stabenow. Thanks for the great work you do on the Ag Committee, too, with the overlap on environmental issues. Thanks so much.

Senator STABENOW. Thank you.

Senator CARPER. We have been joined by Senator Mark Kelly from Arizona.

Senator Kelly, thanks for joining us, and you are recognized.

Senator KELLY. Thank you, Mr. Chairman. The acoustics are not great in this room. Just an observation. Maybe it is the sound system.

Administrator Regan, thank you for being here today. I may have a PFAS question as well, but first I want to ask you about abandoned uranium mines.

There are over 500 abandoned uranium mines on the Navajo Nation. I was really pleased to see the outline of the EPA's fiscal year 2022 budget proposal and how it includes more than $900 million for a new accelerating environmental and economic justice initiative.

Will the EPA's existing work on abandoned mine cleanup be included as part of this initiative?

Mr. REGAN. I believe that will have some role in those activities. Where EPA's role is appropriate in partnership with our other sister agencies, we will be there to focus on that issue.

Senator KELLY. These uranium mines, as you know, are affecting the health of thousands of Navajo people.

How will this work on this new initiative, fit into the existing work outlined by the EPA in the 10 year plan to address impacts of uranium contamination on the Navajo Nation which was released back in January?

Mr. REGAN. Part of our work is improving, at the President's directive, he has indicated that all agencies need to improve the consultative process with our tribal leadership. So what we are doing is we are engaging there to look at these contamination issues, especially the pervasive issues that impact water quality, not only from a public health standpoint, but from a cultural impact as well.

So as we look at deploying these resources around environmental justice, environmental equity, and sort of these reclamation issues, we are very sensitive to engaging these stakeholders as we look at the best way to move forward.

Senator KELLY. Thank you. I look forward to seeing progress on the uranium mine cleanup issue on the Navajo Nation.

On another topic, in 2015, the Obama era EPA issued national minimum criteria for existing and new coal combustion residual landfills. These regulations, which were finalized in November 2020, including a pilot program which allowed facilities to conduct alternate liner demonstrations. In two Arizona facilities, the Coronado Generating Station and the Apache Station, they each applied for the program in November 2020.

But to date, the EPA has not provided an update on these applications. So they applied for this program to conduct these demonstrations with this alternate liner in their landfills. This delay is jeopardizing the success of these pilot projects and placing significant costs on these facilities in the State of Arizona.

Given that there is no active litigation related to this rule, what is the EPA's timeline for reviewing the CCR Part B applications?

Mr. REGAN. I just recently had a briefing on this a couple of weeks ago. I think that as we are taking a look at the past actions of the previous Administration, there is an analysis being done to ensure that as we make decisions, especially as we look at lining and technological opportunities to prevent water quality impacts, that the best science is used to protect public health.

I know that my team is actively reviewing these applications in terms of exactly where we are in that review process. I can have staff get back to you on that, just so that you have some certainty and know what to expect.

Senator KELLY. I would really appreciate that.

I know Senator Stabenow asked about PFAS, and we don't have much time. We have an issue, as you probably know, at Luke Air Force Base recently, which is right outside of Phoenix. They had to issue some warnings to households and businesses near the base about elevated PFAS contamination in the drinking water.

This is in addition to existing PFAS contamination around other bases, Davis Moffett in particular, which is in Tucson. These contaminations are especially concerning to me, because it is Arizona, and we don't have a lot of water like other States do. Aquifers are an important source of our drinking water. As drought conditions worsen, that becomes more critical.

Tell me if you already answered this for Senator Stabenow, but I understand you announced the creation of an EPA council on PFAS yesterday. How will the work of this council help EPA provide a national drinking water standard, or promulgate CRCLA regulations?

Mr. REGAN. I think it is complementary to that. I know for sure that when we look at the increase in the 2022 budget, when we look at the President's American Jobs Plan, there are significant resources there to take a look at PFAS.

So as we continue the work that we are doing to set the drinking water standard and look at the proper designation, what I have decided to do is instruct this council to look across EPA more broadly so that we can go beyond just the drinking water standard, and looking at the designation and think about comprehensively across all of our programs, what can we do to bring the full force of EPA to begin to remedy these issues that we are seeing all across the country.

In addition to setting these standards and designations, as you know, and as you rightfully pointed out, there are a lot of remediations that need to occur. We need to have resources at the Federal level to begin to jump start some of that cleanup now.

I spent about an hour and a half yesterday with individuals from all across the country outlining for me personal stories about their particular impacts and exposure and family loss and personal loss based on PFAS. This is a top priority for this Administration.

Senator KELLY. Thank you for making it a priority. I really appreciate that.

Thank you, Mr. Chairman.

Senator CARPER. You are welcome. Thanks for joining us today, Mark.

Senator Ernst, good to see you. You are recognized.

We have been joined by Senator Sullivan, who I think is on deck.

Senator ERNST. Thank you, Mr. Chair.

Thank you, Administrator, for being in front of us today. I appreciate it.

As an Iowan who strongly believes in our renewable fuel standard, we will start in that area.

Administrator, recent studies indicate that the greenhouse gas reductions from the first generation conventional corn ethanol are almost 50 percent relative to gasoline. When properly administered, the RFS has the ability to dramatically reduce emissions from our transportation sector.

But I am growing increasingly concerned that every time an Administration official talks about biofuels, they only do it in the context of the new fuels and the new markets such as aviation and marine fuels. Can you please set the record straight on where the Administration is with their commitment to ethanol and biodiesel usage in the transportation fleet of today and of the future?

Mr. REGAN. I think that is an excellent question, and I will say that the President has indicated from day one that agriculture is at the table. Secretary Vilsack and I are having these conversations. There is no intent in terms of exclusion when we talk about the promising future of electric vehicles, or when we talk about the promising future of advanced biofuels.

The reality is that as we talk about these promising futures, we have to deal with here and now and a glide path to get to these promising futures. What we know is that ethanol plays a significant role in providing those resources here and now, today, and will evolve as we start to look at the new futures for advanced biofuels and electric vehicles.

Senator ERNST. Do you think that corn ethanol will still continue to have a place, and do you see it having a larger role in the future, a smaller role? What do you anticipate?

Mr. REGAN. I think that is where I am engaging with the ag community, with the farm bureau, with ag CEOs, to best determine where they believe the markets will go, to best understand where they believe the evolution of ethanol will be. It is our job to ensure that that vision coincides with the vision that we see for the lowest carbon economy in the future.

Senator ERNST. I appreciate that. I hope you continue to work with the stakeholders. They will be very valuable in providing input. But you know, again, strong advocate for the RFS. I think it has a significant role to play in reducing greenhouse gas emissions.

Administrator, in a recent House hearing, you said in regard to WOTUS, we don't have any intention of going back to the original Obama Waters of the U.S. verbatim. That was welcome news to me and to many of Iowa's farmers and ranchers.

Now that you have committed to not reinstating the exact Obama rule, what should we expect to see if you decide to make changes? Will it be something that goes even further than the Obama Waters of the U.S. rule? Or will it be something closer to the President Trump administration's rule?

Mr. REGAN. I think that that statement was to indicate that we are just not going to pull a rule off the shelf, especially after we have learned so much over the years. So that is not to be dismissive of what was done in the past. But I think there are some lessons learned.

We are also not quite satisfied that the Waters of the U.S. developed under the Trump administration is as protective of water quality as it could be, while not placing administrative burdens on our small farmers.

What I am not willing to do is prejudge the outcome without an earnest engagement with our ag community. I have pledged to engage with our agriculture community. I pledge to work with USDA and Secretary Vilsack. We are going to set up a structured stakeholder engagement where we actually sit and listen to those who are impacted by our regulations and come to some conclusions on what is the best way to move forward without ping ponging back and forth, protecting our water quality, and not overburdening our farmers.

Senator ERNST. Good. Stakeholders, again, very, very key here.

The Biden administration has had two recent opportunities to demonstrate that low carbon biofuels have a place in their greenhouse gas reduction efforts. A $2.3 trillion infrastructure bill, and most recently in the new 2030 emission target released last week, but neither of these contain much mention of or support for biofuels. So I am growing, again, increasingly concerned that every time the Administration talks about biofuels that they continue to do it in the same manner.

As we are looking at that, can you agree that advanced biofuels should be part of the Nation's strategy to address carbon emissions?

Mr. REGAN. I think the President is very clear on this, that agriculture is at the table and that biofuels play a role in reducing our carbon footprint, and so do many of the voluntary practices of our ag community to capture carbon, and to operate in a sustainable manner.

So again, I think the President has been very clear that agriculture is at the table and plays a significant role.

Senator ERNST. Good. And we would love to hear our Administration officials really talking about the place that ethanol and biodiesel play, whether it is reducing greenhouse gas emissions or otherwise providing affordable fuels to our American citizens.

We really want to hear more about that, to understand the commitment behind the RFS from this current Administration.

Thank you, Administrator. I really appreciate your time.

Mr. REGAN. Thank you.

Senator CARPER. Senator Ernst, thanks so much for joining us and raising those important issues.

Senator Sullivan has joined us.

Senator Sullivan, welcome aboard.

Senator SULLIVAN. Thank you, Mr. Chairman.

Administrator, welcome. Congratulations again on your nomination and confirmation.

I want to talk a little bit about this issue that has been highlighted a lot by the Biden administration on racial equity as it relates to environmental issues, job opportunities. I want to talk about the very large population of Alaska Natives in my State who I think often get left out of this conversation on racial equity.

Two areas, water and sewer, and broader economic opportunities. As you and I discussed, there are over 30 communities in Alaska—and it shocks most Americans—that don't have water and sewer, don't have flush toilets, don't have running water.

When you get up to Alaska, Administrator, you will see these are some of the most patriotic communities in the country. Alaska Natives serve at higher rates in the U.S. military than any other ethnic group.

Can you commit again to work with me? We have had a number of good, bipartisan pieces of legislation through this Committee to help disadvantaged communities that essentially don't have water and sewer. Most Americans assume every American have those. We don't. Thousands of my constituents, and it is really outrageous. I would like very much your commitment. I think you are committed to that, but that is certainly in my view a racial equity issue.

Mr. REGAN. I will tell you, we are committed to it. I recognize that in Alaska there is about $1.2 billion and $1.5 billion worth of wastewater and water infrastructure needs. You will see that that is central to the 2022 budget request here at EPA, is to provide those precious resources to those who need them most.

You will also see that request in the American Jobs Plan, with that $111 billion request. Your State and so many States, we estimate $743 billion worth of water infrastructure and infrastructure needs.

To your point more specifically, not only are we looking at those infrastructure investments, but we are looking at water affordability as well, and water quality. So you have my commitment to work with you.

Senator SULLIVAN. Thank you.

Let me go to another issue, and this is a broader economic opportunity. This is where I hope I can get your commitment.

I am dubious, though, there have been nine Executive Orders issued by President Biden targeting Alaska, nine. I don't think there is any other State in the country, certainly not Delaware, as I have said in Senate floor speeches. If there were nine Executive Orders targeting the economy and jobs of Delaware, the Chairman, everybody else would be on the floor pounding their fists. But my State seems to get a lot of love from this Administration. We don't like the love, right, because it is job killing, it is going after oil and gas jobs.

Let me show you a chart here very quickly. I think I have showed this to you before, Administrator. This is from the American Medical Association, if you can see this. This was a study from 1980 to 2014, what places in America did life expectancy go up or down. In my State, it went up the most, the purple, the blue, that is up to 13 years, in 25 years, people lived longer. No policy indicator of success more important than the people you represent live longer.

Here is my concern. They live longer in my State because they had jobs, because they had resource development, because they are developing oil and gas. Do you think we still need oil and gas in America today?

Mr. REGAN. There is no doubt that natural gas plays a critical role.

Senator SULLIVAN. And oil?

Mr. REGAN. And oil.

Senator SULLIVAN. I appreciated your comments during your confirmation process. You didn't want to put anyone out of work, that wasn't your goal, correct?

Mr. REGAN. That is correct.

Senator SULLIVAN. So right now, unfortunately, we have a lot of Executive Orders that are doing just that. Gina McCarthy, John Kerry are essentially saying we need to limit and unilaterally restrict production of American energy.

The mayor of the North Slope Borough, Inupiat Alaska Native leader, in an op-ed last year in the Wall Street Journal entitled Goldman Sachs to Native Alaskans: Drop Dead, I would like to put this in the record, Mr. Chairman.

Senator CARPER. Without objection.

[The referenced information was not received at time of print.]

Senator SULLIVAN. He mentioned that as investors are being told, don't invest in Alaska's energy sector, John Kerry is doing that, by the way, that this is a concern that these banks are "demonstrating the condescending subtly racist attitude that has been a hallmark of the way westerners deal with indigenous people." That is from this article, saying, don't invest there without asking the Native people there.

The vast majority of the people I represent want economic opportunity in these places, including in the energy sector. I think this is an issue of racial equity that doesn't get mentioned very much. There is this project, the Willow Project, that we have talked about, 2,000 direct jobs at stake right now the Biden administration has put on hold.

Administrator, can I get your commitment to continue to work with me not to kill these really important American jobs that have already been permitted, that in my State often impact Alaska Native communities overwhelmingly, and they are overwhelmingly supportive of them? I think it is putting racial equity on its head to target oil and gas jobs in communities that are primarily indigenous. What is your thinking on that?

Mr. REGAN. My thinking is, and I am proud that this Administration has pledged to put environmental justice and equity at the center of all we do.

Senator SULLIVAN. Is it racial equity and environmental justice to put Alaska Natives out of work just because they work in the energy sector?

Mr. REGAN. What I can say there is I know that the President has put a pause on these types of activities, and this actually falls in Interior's bailiwick, Secretary Haaland's. My pledge to you is to partner with you to be sure that everything that we do is racially sensitive, equitable, and culturally sensitive. That is part of EPA's DNA.

And I can tell you that EPA's attitude as it relates to oil and gas is focused on deploying regulations that accentuate the technologies available to reduce methane. It is not to target individual projects; it is not to kill projects. It is focused on the opportunity that we see with the application of technology that we can use domestically and export internationally.

So you have my word that we can work together to focus on that application of technology, do it in a culturally and racially and economically sensitive way because that is what EPA's aim is for.

Senator SULLIVAN. Thank you.

Thank you, Mr. Chairman.

Senator CARPER. You are quite welcome. Thank you for joining us today and for those questions, Senator.

We may be joined remotely by some others or in person by some other members, so I can go last.

How are you holding up down there?

Mr. REGAN. It is a friendly crowd; I am doing well.

[Laughter.]

Senator CARPER. Do you feel like this is a home game or an away game?

Mr. REGAN. Back home.

Senator CARPER. Oh, good.

We discussed a little bit earlier, the President announced, I think it was last week, that our country would take actions by the end of this decade that would reduce our Nation's greenhouse gas emissions. I think it was like 52 percent below what they were in 2005. This announcement helps, we think, we hope, to put our country on a path toward net zero emissions by 2050, as you know, a goal I have supported for some time.

As you mentioned, the Environmental Protection Agency is going to play a pivotal role in helping us to meet these ambitious but achievable goals. Your agency has regulatory authority under the Clean Air Act and AIM Act, which has been mentioned here, that deals with HFCs—hydrofluorocarbons—and the phase down of those over the next 15 years. You have research programs and you have grant making authority through DERA and other authorities.

My question is, how important is it, in your judgment, that we meet the President's climate goals?

Mr. REGAN. It is absolutely important that we meet the President's climate goals, again, not only because it is an opportunity to save the planet and mitigate against the climate crisis. But this is a significant opportunity for this country to create millions of good paying jobs and really leverage market potential and technological advancements. This is a win-win-win for our country.

Too often, we are talking about or others are talking about, what China is doing, what India is doing, this is about American leadership. I think that the President has rallied the world and indicated that we are back, that science is back, and this is an important moment for this country.

Senator CARPER. Thank you. Achieving the President's climate goals is going to require EPA to be performing at its best. I understand over the past 4 years, EPA lost nearly 1,000 staff members from its headquarters and regional offices. I can imagine that this sharp decrease in staff could hinder the agency's ability to effectively carry out its core duties and function to protect public health and the environment.

Could you just take a minute to share with us this morning any steps that you have taken or plan to take to be able to rebuild the agency by backfilling key positions and bringing on more staff? How does this budget proposal assist those efforts?

Mr. REGAN. Thank you for that. I think it starts with rebuilding morale. No one wants to work at a place where they don't feel valued. We spend quite a bit of time rebuilding the morale in this agency and letting our staff know that they are valued.

We are hoping that we can recruit back many of the employees that we lost. We lost over 1,000 employees over the past 4 years. But we don't only want to look at what we lost, we also want to recruit and retain the best and the brightest, because we are looking ahead. We are looking toward the future.

So my leadership team is really rallying around lifting the morale, lifting the organizational health, and putting a recruitment and retention process in place to get the best and the brightest at EPA. Because we need to be in fighting shape.

This budget is a serious signal to the agency that we are being invested in, and we are going to be given the tools we need to protect the environment, public health, and the economy.

Senator CARPER. Several years ago, I was privileged to Chair another committee, Homeland Security and Governmental Affairs Committee. We found there is an annual report done measuring morale, good or bad, among major Federal agencies. Year after year, we found that the agency with the lowest morale was Homeland Security.

Jeh Johnson, you may recall, was the Secretary; Mayorkas was the Deputy. They concluded one of the causes for the low morale was the lack of Senate confirmed leadership within the agency. I would describe it as executive branch Swiss cheese.

Tom Coburn and I went to work. He was the ranking Republican on the committee at the time. We went to work to try to make sure we addressed that.

And we did. We work very hard, as I am sure you know, to try to make sure that the President's nominees to help fill out the leadership team at EPA are pursued and confirmed. That is why we felt that Janet McCabe was so important last week.

I just wanted to mention that in terms of morale. We hope that the leadership team, an excellent leadership team that has been confirmed, will help raise that morale and do it sooner rather than later.

Earlier this month, you announced a series of actions you plan to take to advance environmental justice, one of which was at a roundtable that I had the opportunity to join. You have also directed EPA staff to incorporate environmental justice considerations into their work across the agency. I am encouraged about this effort to advance environmental justice. I think we all are.

My question would be, will you share with us any other actions you have taken or plan to take in order to address the historic failure to meet the needs of disadvantaged communities, and how does this budget proposal assist those efforts?

Mr. REGAN. This budget proposal is critical. This budget proposal is critical as well as the American Jobs Plan. There are precious resources that are tucked in these proposals that give us the ability to help these communities that need it the most through grant applications, through advanced monitoring for air quality and water quality. And just the ability to provide the infrastructure, so that these communities can communicate with us and use the data we provide to help uplift their communities through health, through equity, through economic opportunities.

So EPA has pledged that environmental justice and equity will be part of our DNA. We plan to meet that moment.

Senator CARPER. All right, thank you.

I understand Senator Padilla is on Webex.

Senator Padilla, are you there?

Senator PADILLA. Yes, I am, Mr. Chair.

Senator CARPER. We will go ahead and recognize you at this time.

Senator Sullivan, I understand you have another question. After he goes, you are next.

Alex, go ahead, please.

Senator PADILLA. Thank you, Mr. Chair.

First, Administrator Regan, I want to begin by thanking you for following through on President Biden's commitment to reexamine the States' One Rule. I certainly appreciate your support of California's longstanding statutory authority to set greenhouse gas and zero emissions vehicle standards.

California is and has been a national leader in the fight against climate change and eliminating toxic pollution from our transportation sector. So I appreciate your early leadership and early collaboration.

I also want to elevate yet another issue that I am hoping is a good topic for collaboration in my State. It begins with personal experience. I know first hand how outdated school buses expose children to harmful pollution. I experienced it every day in the years when I was in junior high and elementary school, riding the school bus to and from in the San Fernando Valley. That smell of diesel exhaust that would fill our lungs, not just mine, but every student that was on that bus on the way to school, on the way from school. I can still smell it today.

Speaking of today, we know that there are 25 million children across the United States that are still exposed to the same diesel exhaust when they ride 500,000 predominantly diesel buses. We know it is not just an environmental impact, it is also a health impact, and it is an academic impact, because when the kids have health issues, respiratory issues, because of the exhaust that they are breathing. It affects their ability to learn, and their academic performance.

So as we work to build back better, and address climate change, I believe it is imperative that we work with school districts to supply the resources necessary to accelerate the deployment of zero emission electric school buses to reduce the exposure of children to greenhouse gases, while improving the public health, the environment, and academic learning.

So I am proud that, along with Senator Warnock and Representatives Cardenas and Hayes, that we introduced a Clean Commute for Kids Act this last week. It seeks to build on an initial proposal in the infrastructure plan. It goes just a little bit bigger, it goes a little longer, to accelerate this transition.

So I am asking, Administrator Regan, why you believe this plan to work with districts to accelerate the transition to zero emission electric vehicles, is good and leads us to more equitable, sustainable transportation infrastructure?

Mr. REGAN. Thank you for that, and thank you for your leadership. I agree with you that electric school buses are critical for not only the health and well being of our children, the precious cargo, as they go to and from school. But to the point you just made, it really has an impact, not only on them physically, but mentally and emotionally as well, if they cannot breathe while they are sitting in class attempting to learn.

Another benefit of electric school buses, and I have had this conversation with rural electric cooperatives, is once that precious cargo is dropped off, and those school buses are parked, their batteries become available to plug into the grid and begin to provide a level of reliability and certainty to that grid that they don't have

to rely on dirtier fuels, fossil fuels and the like. So there is a win-win there. There is a transportation piece to that; there is a public health and education piece to that.

But then you dovetail back into infrastructure. Electric vehicles, in general, can help shore up our grid and create reliability and capabilities. I think electric vehicles are just so important for greenhouse gas emissions on the road as well as those that are generated through electricity production.

Senator PADILLA. Thank you very much. I have limited time left, I want to talk about one other issue that we have discussed in the Committee prior, and that has to do with not just the need to invest in water infrastructure, but water affordability.

We know that in California alone, one in eight households in my home State are a little bit behind or more than a little bit behind on their water bill to the tune of $1 billion. It is a much bigger number across the country, as you can imagine.

As we work toward investing in our infrastructure, can you speak to the wisdom of a national water affordability program, to help people who are struggling to keep up with water rates, let alone face higher bills, to help fund some of the infrastructure investment that is needed?

Mr. REGAN. It is critical that we focus on water affordability. We are doing that through our 2022 budget request. We are also doing that throughout the President's request of $111 billion in the American Jobs Plan.

Water affordability is critical. The good news is EPA has experience here. We have existing water financing programs that we have been operating for a number of years where we have invested billions of dollars and created hundreds of thousands of jobs. I believe that as we take a closer look at the resources that we are asking through the American Jobs Plan and our budget that we will be able to do a better job of dovetailing water affordability into our traditional grant and loan programs.

To the point you just made, there are so many water systems across this country that cannot afford a zero interest loan, because they are just in that bad a shape. That is where the grant programs come in to help them begin to tread water a little bit better.

Senator PADILLA. Thank you very much. I look forward to our continuing work together.

Senator CARPER. Senator Padilla, while you are still with us, before I recognize Senator Sullivan again, I would just mention a couple of things.

Senator SULLIVAN. Thank you, Mr. Chairman, I just have one comment. And then——

Senator CARPER. Senator Sullivan, just wait 1 minute. I want to mention a point that he has raised, and then you are recognized. If you would just give me a minute.

Senator Padilla, you are probably familiar with something called the Diesel Emission Reduction Act. It is legislation that Senator George Voinovich and I introduced 10, 15 years ago. It has continued to enjoy bipartisan support. Senator Inhofe is my wingman on that now.

We continue to push for increased funding for the Diesel Emission Reduction Act, which should help address the issue that you

raised here. I would ask you to feel free to join us as a partner in that.

The other thing I would say, we are really encouraged by the advances that are being made for automotive of all kinds, including F–150 trucks, all kinds of cars, trucks, and vans using electric vehicles and becoming more affordable and actually much greater ranges.

Sometimes overlooked are hydrogen fuel cells, the use of hydrogen and fuel cells to create electric powered vehicles. The only waste product is water, H_2O.

What I am told by people a lot smarter than me is going forward into the future, we are going to continue to use more and more, and see more and more electric powered cars, trucks, and vans on the road. But as time goes by, hydrogen and fuel cells with larger vehicles, trucks, mid-size and large trucks will be more common. So there is a combination.

As we work on our surface transportation legislation, we are committed to helping create corridors of charging stations and fueling stations, fueling stations for hydrogen. So it is going to take a combination of those two.

Thanks so much, Senator Padilla.

Senator Sullivan had one last question. Then the gentleman from Mississippi.

Senator SULLIVAN. Just a comment and question. Thank you, Mr. Chairman.

Just a word of caution, Administrator. You don't get the good paying jobs in the future, which is what the Biden administration is talking about, millions, by killing good paying jobs in the present. And you don't get to environmental justice and racial equity by killing good paying jobs and economic opportunities in Alaska Native communities.

So I am going to keep a close eye on that. I appreciated your responses to my questions today. And I appreciated you being here.

Here is my final question. It is an important one. You are here right now. Senate confirmed, taking questions, oversight. That is the constitutional role that you and we have.

I was surprised to see in the New York Times 8 days ago an article, I would like to submit it for the record, Mr. Chairman.

Senator CARPER. Without objection.

[The referenced information was not received at time of print.]

Senator SULLIVAN. It was on climate czar Gina McCarthy. It mentioned she was the "most powerful climate and energy official in the country other than Mr. Biden himself." Shocked again to see you weren't mentioned in the article at all, not once. She actually claimed she was the "orchestra leader for a very large band" on these issues.

You might recall my concern, Senator Capito's concern during your confirmation hearing, that she would be, with her radical activist driven views, out of the mainstream, she wouldn't have been able to get confirmed here, that she would be in charge of these issues, EPA issues, not you. And this article again just 8 days ago led me to raise this question again.

We can't call her to do what you are doing, and again, I appreciate what you are doing, to testify, to have oversight, to hear what

she is really up to. This article made it sounds like she is driving the whole agenda, the regulatory agenda, at EPA.

So let me ask you this again. Is czar McCarthy dictating the agenda at EPA? It is a concern of so many of ours. The New York Times has this glowing piece about her. You are not mentioned once. Who is in charge? Who can come here and testify?

Again, I appreciate your testifying. But I don't appreciate the fact that her views seem to be overriding yours.

Mr. REGAN. I can say that I haven't read the article. I think the indication there, though, is that Gina is working across all of our agencies. I am not sure if the article is calling me out specifically. I think what Gina——

Senator SULLIVAN. Well, it was almost all on EPA.

Mr. REGAN [continuing]. Maybe mentioned, there is a whole of Government role. I think Gina is doing a really good job of conversing with me, and DOT, and DOE, and USDA, all across the board.

I can assure you that Michael S. Regan is in charge at EPA. I can assure you that when you look at the role that EPA plays in regulatory development and all the conversations that we are having that those conversations are being had within the agency, and we are following the law, and we are exercising our statutory authority.

At any given time, with any member, I am willing to show up and have a conversation about any aspect of what we are doing. I think if we sit down and talk about what we are doing, you can pick apart everything that we are doing, and you will see that those ideas, that information, that analysis and that good work is coming out of EPA and the staff at EPA.

Senator SULLIVAN. Good. I appreciate that, Administrator. I appreciate you being here, answering these questions, tough questions, easy questions. But it is important for us to know who is in charge.

Thank you, Mr. Chairman.

Senator CARPER. You bet.

A couple of years ago, Senator Sullivan, when I was elevated, being Chair of the Homeland Security Committee, there was an article in the New York Times as well that indicated who the new Chairs were going to be. Democrats were suddenly in the majority, and it was noted I was going to be Chair of the Homeland Security and Governmental Affairs Committee.

It went on to say that I was a Senate expert, a Senate expert, on cyber security. I showed this to my wife, I said, Martha, look at this, your husband is now the Senate expert on cyber security. What do you have to say about that? Her response was, in the land of the blind, the one-eyed man is king.

[Laughter.]

Senator CARPER. Senator Wicker.

Senator WICKER. Thank you very much, Mr. Chairman. It is great to be here. I will not take a lot of time.

Let me just say, I want to renew my invitation to the Administrator to come to Mississippi and see a place called the South Delta, were in 9 of the past 10 years, we have had devastating

floods. I think the Administrator is going to be able to do this, Mr. Chairman.

We have a plan that developers, homeowners, small businesses, environmental activists should all support. I think we finally got it right. It absolutely does involve the environmental justice that Senator Sullivan was talking about. But these floods, for the last 9 out of 10 years, have devastated wildlife and destroyed many people's livelihoods.

I think we have a plan now that enhances and protects wildlife, will save animals and fish and birds, and give certainty to people in this area that actually need help. Frankly, it is some of the most disadvantaged people anywhere in the country that are devastated by this flooding that we have not been able to come to a consensus about.

So I want to renew my invitation to Mr. Regan and to say I appreciate the opportunity to work with you in the future.

Mr. REGAN. Absolutely.

Senator WICKER. I yield back my time, Mr. Chairman, and thanks for extending this hearing so that I could get back from my emergency visit to the dentist.

Senator CARPER. Just for you. While you are here, I mentioned this earlier, we appreciate the leadership that you and Senator Ben Cardin have provided on some aspects of our water infrastructure legislation, which will be debated and hopefully adopted tomorrow on the floor.

We are grateful for the contributions on that to you and your staff. Thank you.

Senator WICKER. Thank you, Mr. Chairman.

Senator CARPER. You bet.

I am going to ask a couple more questions, and I will ask again, Administrator Regan, are you OK?

Mr. REGAN. Yes, doing well.

Senator CARPER. I said, check with his staff to see if he is able to handle another question or two. They said, go for it.

As a follow up to, I think it was Senator Kelly's question, with respect to low income and communities of color bearing a disproportionate amount of the impact from polluted Superfund sites, according a 2020 report, 70 percent—70 percent—of the country's most environmentally contaminated sites are located within one mile of federally assisted housing.

I will say that again. According to a 2020 report, this is amazing, 70 percent of the country's most environmentally contaminated sites are located within one mile of federally assisted housing.

Could you talk for a minute or two about any plans you may have to address that longstanding problem?

Mr. REGAN. Absolutely. Thank you for that question. This is why the 2022 budget request and the American Jobs Plan is so important. When we look at the resources in both of these places, they increase EPA's ability to expedite the cleaning up of brownfield sites and Superfund sites, which to the point you just made, are located in these communities that already bear a disproportionate burden.

I am happy to say that I have had a couple of conversations with Secretary Marcia Fudge and HUD to think about how we can tag team this effort as well.

Senator CARPER. Good. Keep talking. That is an amazing number. Isn't that an amazing number? Have you heard that before, 70 percent within a mile of federally assisted housing? That is unbelievable.

All right, next question with respect to renewable fuel standards, as discussed a bit earlier with Senator Ernst and others. Recently I wrote a letter along with my colleague Senator Chris Coons and Congresswoman Lisa Blunt Rochester, to you in regard to renewable fuel standards. In the letter, we mentioned the need for EPA to take action to address the volatility in the RFS compliance markets. This includes providing some compliance flexibilities that reflect the COVID challenges, doing more to address market manipulation, and finally, acting on the applications for new, advanced biofuel pathways and fuels.

My question is this, do we have your commitment that you and EPA, your EPA team, will make it a priority to work to stabilize the RFS market and that the program works as intended? Also, will you commit today to meet with myself and others in our delegation to further discuss this issue?

Mr. REGAN. Absolutely. I can commit to both of those.

Senator CARPER. All right, great.

We have in our State an oil refinery. When I first came to Delaware, right out of the Navy, at the end of the Vietnam war, I enrolled at the University of Delaware to get an MBA. One of my requirements in a course I took my first semester of graduate school was a course looking at the Delaware business that was under investigation, always under fire by the Federal Government or the State government for their alleged abuses and irregularities.

I didn't know anything about Delaware. I had been there like 2 weeks, and I was in this course. I started reading the paper, they had one major daily paper. I started reading the paper to find out what business or company was maybe a good subject for me to cover in my report. And I just kept reading stories day after day after day, about the Getty refinery, which is one of the worst polluting refineries on the East Coast. Terrible place for all kinds of air emissions, water emissions.

That was my introduction to that refinery. Today, the refinery is still alive and hanging in there, but a much, much better environmental steward, much, much better, incredibly better. And a part of that happened when I was Governor, and this man right over here, Christophe Tulou, was our secretary of natural resources and environmental control, your counterpart from Delaware. So we are proud of the progress that has been made.

They provide job employment opportunities to about 1,000 people in our State, which is a lot of people in a little State, and good paying jobs. They have concerns with respect to the chaos that comes out of the RINS market. This is something that is real, it is a matter of concern to us. And at the same time, we think it is important that we create renewable fuels and that they are environmentally friendly and help us fly airplanes and send ships out to sea and so forth.

So I appreciate your assurance, and we look forward to following up with you on this front.

Vehicle emissions standards, I think I have been working on this since childhood. During your exchange with Senator Markey an hour or so ago, you discussed the revolution that is happening today in the automotive sector. Car company after car company announcing moves to electric vehicles and hydrogen powered vehicles as well.

Ford announced that all of its vehicles that it sells in Europe will be electric by 2030; Jaguar will go electric in 2025; Volvo has announced that it will sell only electric cars by 2030. Volkswagen has announced it plans to increase its sales of electric vehicles such that 50 percent of the vehicles it sells in the U.S. and China will be electric by 2030.

Honda has announced plans for 40 percent of its sales to be zero emission vehicles by 2030, 80 percent by 2035, and 100 percent by 2040. And General Motors has announced plans to produce only electric vehicles by 2035. GM is also in a partnership, I believe, with Honda, on fuel cells, which is something that is quite promising.

And there are a number of companies, including Toyota, very much into fuel cells with hydrogen. I think there is at least one South Korean company, but there are a bunch. As I said earlier, the focus there is mid-size trucks, large trucks, and they put out a lot of carbon, a lot of greenhouse gases. So that is all encouraging and important.

However, having said that, EPA hasn't typically factored in availability, the availability of electric vehicles in establishing emission standards. This is a big issue. I think it is too big to ignore.

Your thoughts, if you will, will EPA consider the increasing availability of electric cars when setting vehicle emission standards? I will say this again, will EPA consider the increasing availability of electric cars when setting vehicle emission standards?

Mr. Administrator, would you look for further correspondence from me on this issue? A couple of colleagues and I will be sending that to you.

With that, my question is, will you consider the increasing availability of electric cars when setting vehicle emissions standards?

Mr. REGAN. We do. We take those market considerations under consideration, market dynamics under consideration. The availability of the technology that needs to be deployed, and the ability for the auto manufacturers to produce the vehicles and keep those jobs here in America.

Senator CARPER. All right. My staff and I are working on a letter with a couple of our colleagues to follow up on this. We would just ask you to be on the lookout for it.

And I think that might be it.

Senator Stabenow joined us by Webex an hour or so ago. She chairs the Ag Committee, and she is a new member of this Committee, and a very valued colleague and friend.

We have in Delaware, we raise, I am told, maybe at one time more soybean than any county, in Sussex County, Delaware, maybe more than any county in America. Little Delaware, we raise a ton

of corn. For every person who lives in Delaware, we have about 400 chickens. Most people don't think of Delaware as an agriculture State, but we are.

One of the concerns we have in southern Delaware, we have some of the best beaches in the country, Rehoboth Beach and Bethany and Dewey and so forth. We are concerned about development, over-development of the areas close to our beaches and shores.

One of the ways to combat that is to make sure that farmers make a good income and to keep the value of their farms and farming so attractive that they wouldn't wait to sell their farms. I am always looking for ways to do good things for our planet, for our environment, for our air, and create jobs and economic opportunity.

Will you think out loud for a minute how we can take carbon sequestration, how can we take that technology and the ability to infuse that into the soil to enrich the soil to make it more productive and to create an economic model that rewards farmers for keeping, continuing to farm and to being even better environmental stewards than they are already? Is this something that you have thought about in North Carolina, or even at EPA since you have gotten there?

Mr. REGAN. Absolutely. I think that what you just described is an excellent opportunity and why the President has insisted that agriculture stay at the table.

While we look at the opportunities to sequester carbon, we don't have to look at that through solely a regulatory means. It is an opportunity that USDA and farmers are proactively looking at, that we need to quantify and consider as part of the equation.

I think it is an excellent opportunity for all of the reasons you just laid out. It keeps the farms in the family, it is a good revenue source, and it also helps with combating the climate crisis.

Senator CARPER. Thank you. I mentioned earlier, and I am not sure who was here, my wife and I come home from church on Sundays, we come home, and we fix breakfast in our kitchen, and we turn on the television and watch a fellow named Fareed Zakaria. He holds forth for about an hour. He has some really interesting stuff.

This last Sunday, the last 4 minutes of his show he spent talking about how to, in times when the sun is not shining and the wind is not blowing, how do we make sure we have the ability to produce electricity. He focused on next generation nuclear power. It was enlightening and encouraging.

I am a retired Navy captain, I spent a lot of years of my life on ships or submarines. I have been on a bunch of them. In all the 70 some years that we have been producing nuclear power for ships, submarines, and aircraft carriers, not one sailor has ever died from exposure to radiation.

We have some interesting things, very interesting things that are going on in new technology with respect to advanced nuclear. This is something this Committee has been interested in. We passed legislation in this regard. You don't have to respond unless you want to, but this is something that we think is another arrow in our quiver, and we would be foolish to ignore it.

Any thoughts you have, I would appreciate it.

Mr. REGAN. I agree with that statement. I can tell you, Secretary Granholm speaks very eloquently about where that technology is and how it is applicable, especially when we look at grid reliability and reducing the carbon footprint. So I think it is an excellent opportunity to advance the cause to fight climate change mitigation.

Senator CARPER. All right. Again, I am going to do some housekeeping right now, and then I will say thanks for one last time.

For some final housekeeping, Senators will be allowed to submit questions for the record through close of business on May 12th. We will compile those questions and send them to you, Mr. Regan. We would ask that you try to reply to us by May 26th, that is about 2 weeks.

And with that, thank you for joining us today. This is something that we haven't done for a while, to have a budget hearing and have the Administrator here and to say what this is for this time, and be as forthright as you have been in your responses in this discussion. We look forward to doing it again, and again, and again. And maybe again.

Thank you so much. My best again to your family, especially that young son of yours, Matthew, 8 years old. We will always remember, you did a great job at your confirmation hearing, but he sat right behind you for 3 hours, and he won the prize. Give him our best.

With that, I think this Committee hearing is adjourned. Thanks.

[Whereupon, at 12:10 p.m., the hearing was adjourned.]

[Additional material submitted for the record follows. Due to size constraints some documents are not included below but are available in Committee files.]

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The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
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Washington, DC 20004

Re: PFAS Action Plan Recommendations from EPN

Dear Administrator Regan:

Congratulations again on your confirmation! Thank you so much for your commitment to repairing the damage of the past administration and to advancing bold new initiatives on climate change and environmental justice. As the Executive Director of the Environmental Protection Network (EPN), an organization comprised of over 550 U.S. Environmental Protection Agency (EPA) alumni volunteering their time to protect the integrity of EPA and its mission, I am writing in support of your priority to address the serious health impacts of per- and polyfluoroalkyl substances (PFAS) chemicals in the environment.

EPN is concerned that EPA's current PFAS Action Plan, developed by the Trump administration, is short on measures to reduce exposures to PFAS and will not help us transition away from this harmful class of chemicals. To date, the plan has not resulted in additional health protections nor risk reductions, and lacks a coherent framework for comprehensively addressing the health and environmental impacts of PFAS as a class. EPN believes that a new, more proactive PFAS Action Plan that moves beyond the current approach to PFAS regulation is needed. To guide development of a new plan, we propose an alternative approach that would implement a systematic process for gathering data on PFAS chemicals as a class; prevent introduction of new PFAS and new uses of existing PFAS; address existing PFAS products and raw materials as a class, with the aim of eliminating all PFAS non-critical uses; reduce environmental releases to the extent feasible; and assure the development of information and data to understand the health risks to communities with historical and ongoing exposure to these chemicals.

As EPA develops an improved plan, we hope you will consider the recommendations we have attached to this letter. In drafting this alternative PFAS Action Plan, we reached out to and received input from many environmental and public health organizations active in PFAS issues in an attempt to identify every authority EPA currently has to prevent new health impacts and reduce current health impacts from these toxic chemicals. We hope our recommendations will assist the agency in moving forward quickly to develop a new PFAS Action Plan. We look forward to discussing the details of the plan with your senior leadership team.

Respectfully submitted,

Michelle Roos
Executive Director
Environmental Protection Network

Cc:
Acting Assistant Administrator for the Office of Air and Radiation, Joseph Goffman
Acting Assistant Administrator for the Office of Chemical Safety and Pollution Prevention, Michal Ilana Freedhoff
Acting General Counsel for the the Office of General Counsel, Melissa Hoffer
Acting Assistant Administrator for the Office of Land and Emergency Management, Barry Breen
Acting Assistant Administrator for the Office of Research and Development, Jennifer Orme-Zavaleta
Acting Assistant Administrator for the Office of Water, Radhika Fox

PFAS Action Plan Recommendations from EPN

April 26, 2021

The Environmental Protection Network (EPN) is an organization of almost 550 U.S. Environmental Protection Agency (EPA) alumni volunteering their time to protect the integrity of EPA, human health, and the environment.

Introduction

EPN is concerned that EPA's current per- and polyfluoroalkyl substances (PFAS) Action Plan (the Plan), developed by the Trump administration, is short on measures to reduce exposures to PFAS and transition away from this harmful class of chemicals. To date, the Plan has resulted in little actual health protection and risk reduction, and lacks a coherent framework for comprehensively addressing the health and environmental impacts of PFAS as a class. The manufacturing, use, and environmental release of most PFAS will continue for the foreseeable future if EPA continues to base decisions solely on the current Plan. While certain high-profile substances with validated analytical methods and toxicity data would receive attention, the bulk of PFAS would not be addressed. This would doom additional generations of Americans to exposure to these high-risk chemicals without any effective regulation and health protection by EPA.

EPN believes that a new, more proactive PFAS Action Plan that moves beyond the current failed approach to PFAS regulation is needed because current research finds that the chemicals pose immunological, developmental, reproductive, hepatic, renal, hormonal, and carcinogenic effects. To guide development of a new Plan, we propose an alternative approach that would implement a systematic process for gathering data on PFAS chemicals as a class; prevent the introduction of new PFAS and new uses of existing PFAS; address existing PFAS products and raw materials as a class, with the aim of eliminating all PFAS non-critical uses; reduce environmental releases to the extent feasible; and assure the development of information and data to understand the health risks to communities with historical and ongoing exposure to these chemicals.

PFAS Health Effects

PFAS have been produced since the 1940s for use in a broad range of consumer products and industrial applications. EPA's most recent PFAS Master List of PFAS Substances identifies 9,252 chemicals, clearly highlighting the challenges of an individual chemical approach to regulation. Many more PFAS are formed as byproducts or impurities during the manufacture of PFAS-based products and degradation/reformation in the environment and are found in waste streams, water discharges, and air emissions to which communities are exposed. The recent finding of PFAS in pesticide containers leaching into pesticides poses a potential new source of PFAS contamination of crops, homes, and public spaces where these pesticides are applied.

In response to concerns about long-chain PFAS chemicals such as perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorohexane sulfonate (PFHxS) detected both in the environment and in human biomonitoring studies, industry began developing short-chain PFAS alternatives. While some of these short-chain PFAS chemicals are comparatively less bioaccumulative than the long-chain chemicals, they are equally persistent and even more mobile, also produce adverse health effects, and can build up in the environment and the human body with continuous or repeated exposure. People are exposed to both long- and short-chain PFAS through ingestion, dermal contact, and inhalation via food, water, dust, soil, and consumer products. Studies of both long- and short-chain PFAS have found immunological, developmental, reproductive, hepatic, renal, hormonal, and carcinogenic effects, among others. A recent study found evidence that PFAS exposures increase the severity of the coronavirus in individuals. The Centers for Disease Control and Prevention (CDC) is investigating the impact of PFAS exposure on coronavirus infections by measuring PFAS serum concentrations in healthcare personnel and first

responders and looking for an association between these serum concentrations and the risk of coronavirus infection and subsequent COVID-19. The National Institute of Environmental Health Sciences (NIEHS) is also providing funding for researchers to study the impact of environmental exposures to pollutants, including PFAS, on coronavirus infections. Even those PFAS polymers that are described as nontoxic are made using toxic monomers and processing aids that can be released during production, use, and/or disposal.

The European Union (EU) decided that, based on their persistence and other harmful properties, PFAS chemicals should be subject to the same generic risk management approach as carcinogens. The EU's generic approach for carcinogens is to ban them from most consumer products and for uses that expose vulnerable groups, allowing only limited exceptions for "essential uses" as defined under the Montreal Protocol. The Montreal Protocol defines "essential uses" as those necessary for health, safety or the critical functioning of society when there are no safe alternatives acceptable from the standpoint of the environment and public health. In the U.S., section 6(g) of the Toxic Substances Control Act (TSCA) creates a similar process for exempting "critical or essential use[s]" from risk management rules.

Critique of EPA's PFAS Action Plan

EPA's 2019 PFAS Action Plan focuses on regulating the long-chain carboxylate and sulfonate chemistries (including PFOA and PFOS) because analytical methods and toxicity data are already available for these substances. Even with this limited focus, progress in regulating long-chain substances has been slow. Since 2002, EPA has finalized only four significant new use rules (SNURs) under the TSCA that ban the manufacture or import of long-chain chemistries without advance notice to and review by EPA. These SNURs do not cover all long-chain PFAS and still allow the import of products containing these chemicals, with the exception of carpets and articles with surface coatings containing certain PFAS.

EPA has exempted hundreds of new PFAS chemicals from TSCA premanufacture notice (PMN) requirements and has inadequately restricted GenX and many other new PFAS chemicals regulated under section 5(e) after PMN submission. EPA took two years developing groundwater cleanup guidance for PFOA and PFOS that failed to identify an emergency removal level; spent two years drafting an advance notice of proposed rulemaking (ANPR) asking for public comments on whether the agency should designate PFOA and PFOS as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or the Resource Conservation and Recovery Act (RCRA); and last year began a five-year process to develop a drinking water standard for PFOA and PFOS.

Beyond PFOA and PFOS, progress in developing analytical methods and toxicity assessments for PFAS chemicals has been slow, and short-chain PFAS have received limited attention. EPA lacks a systematic, cross-program process to select PFAS chemicals for analytical method and toxicity assessment development. Those selected to date represent a small fraction of all PFAS used commercially and found in the environment, and EPA's work on these substances will provide limited support for regulation by the air, water, and solid waste programs.

The Plan also lacks a prospective process using TSCA Section 4 test orders to gather analytical methods and toxicity data from industry. Instead, the Plan puts the burden of developing analytical methods and toxicity assessments on EPA. To date, EPA only has analytical methods for 29 PFAS in drinking water while private laboratories are testing for 70 PFAS. EPA has not yet finalized analytical methods for PFAS in air, surface/ground water, and wastewater. EPA has also not certified a non-target method, such as Total Organic Fluorine (TOF) or Total Oxidizable Precursor Assay (TOPA), despite the fact that many commercial labs routinely use these methods. While EPA plans to develop a TOF method in 2021, the agency states in its unregulated contaminant monitoring rule that a TOF method will not be available for monitoring drinking water during the required time period of 2023 to 2025. A test method for 30 PFAS

chemicals in air was just released, but no TOF or TOPA air test method is yet available to gauge the potential for reformation of PFAS compounds after emission from the stack.

The toxicity assessment for GenX proposed in 2018 is still not final, and the assessment for Perfluorobutanesulfonic acid (PFBS) proposed in 2018 was finalized in January 2021 over the protest of the original authors. The Biden administration withdrew that flawed PFBS assessment in February 2021 based on political interference in its findings. Assessments for five other PFAS chemicals Perfluorodecanoic Acid (PFDA), Perfluorononanoic Acid (PFNA), Perfluorohexanoic Acid (PFHxA), Perfluorohexane sulfonate (PFHxS), and Perfluorobutanoic Acid (PFBA) have been underway for three years but not yet made available.

Under the Clean Water Act (CWA), EPA's effluent limitation guidelines program identified five industry sectors discharging PFAS chemicals to municipal wastewater treatment plants or to surface waters. On January 15, 2021, EPA released an ANPR that will initiate a detailed study of one of these five sectors: organic chemicals, plastics, and synthetic fibers manufacturing. It typically takes the effluent limitation guideline program six years from the time a detailed study is initiated until a final rule is promulgated, setting technology-based permit limits on pollutant discharges for an industry sector. That six-year process will have to be repeated for each of the four other industry sectors identified by EPA as PFAS dischargers (airports, rug and textile manufacturers, pulp and paper manufacturers, and metal finishing industries).

While we have enough information on the persistence, mobility, and toxicity of PFAS chemicals to generally support class-based regulation of these chemicals, EPA has made little progress in developing the health effects data on individual chemicals necessary to understand the impacts of past, current, and future exposure from PFAS manufacture, use, and disposal/environmental release. As a result, communities have been subjected to largely undefined risks, and medical professionals have been deprived of the ability to treat PFAS-related health conditions. The limited industry-sponsored health effects research that has been conducted is often declared confidential business information (CBI) and is unavailable to the public or local and state environmental regulators.

Unfortunately, during the Trump administration, EPA failed to use its authority under Section 4 of TSCA to require PFAS manufacturers to conduct testing and to make the results of that testing publicly available. To address this information need, on October 14, 2020, six North Carolina non-profit groups filed a petition under Section 21 of TSCA requesting that the agency require health and environmental effects testing on 54 PFAS being manufactured by The Chemours Company (Chemours) at its chemical production facility in Fayetteville, North Carolina. On January 7, 2021, the Trump EPA denied the North Carolina petition. In March, 2021, the petitioners asked the Biden administration to reconsider the petition denial, grant the petition, and require Chemours to fund testing on the 54 PFAS. Granting the petition would be consistent with the commitments made in the Biden-Harris campaign's Environmental Justice Plan and by EPA Administrator Michael Regan during his confirmation to make environmental justice and addressing PFAS in frontline communities top priorities in the new administration.

New PFAS Action Plan

Clearly, EPA cannot adequately protect the American public if its actions are based solely on the current PFAS Action Plan. EPN, therefore, recommends that EPA immediately initiate the development of a new PFAS Action Plan, which quickly puts in place a comprehensive framework for addressing the PFAS class. The new PFAS Action Plan should be designed to achieve the following goals: 1) develop and implement a systematic process for obtaining necessary data on PFAS; 2) stop or severely restrict the introduction of new PFAS and new uses of existing PFAS; 3) eliminate all non-critical uses of existing PFAS; 4) prevent exposures to legacy or existing PFAS in the environment; 5) fill important gaps in scientific understanding so that the health impacts on communities of historical and current PFAS exposure can be meaningfully

evaluated; and 6) establish strong collaboration across the agency to implement this comprehensive approach. EPA should not stop or redirect any ongoing work on PFAS until the new Plan is fully developed and ready to be implemented.

Developing a Strong Information Base on PFAS

EPA should implement a systematic process for gathering and making public research data on PFAS that provides a sound basis for identifying all PFAS in products and the environment, detecting and quantifying their presence in critical matrices, determining their mobility and fate in the environment, and integrating available toxicity data. This process should aim to supplement the research being done by the federal government and academic investigators with data developed by the companies manufacturing and processing these chemicals.

First, as required by the FY2020 National Defense Authorization Act (NDAA), EPA should expeditiously promulgate a reporting rule under TSCA section 8(a) requiring all companies manufacturing, processing, or using PFAS (including impurities and byproducts) to: 1) identify the ongoing uses of these chemicals; 2) characterize the facilities manufacturing, processing or using these chemicals (number of workers, processing method, chemical levels in products, etc.); and 3) identify worker and consumer exposures (inhalation, dermal, ingestion) and environmental releases (water discharges, air emissions, disposal method). While the NDAA required promulgation of this reporting rule by 2023, EPA should issue it as soon as possible. We understand that a draft reporting rule is now undergoing Office of Management and Budget (OMB) review and support EPA efforts to expedite this rulemaking. In addition, industry will begin reporting in July 2021 on 172 PFAS subject to EPA's Toxic Release Inventory (TRI) as well as any new PFAS covered by the June 2015 SNUR. This reporting should be comprehensive since no PFAS chemicals will be subject to *de minimis* reporting exemptions under TRI.

EPA also has databases for the Chemical Data Reporting Rule (CDR) and Enforcement and Compliance History Online (ECHO) that have information on industrial sources of PFAS. The Department of Defense (DoD) has developed an open library fingerprinting the source of PFAS chemicals. State attorneys general who have sued PFAS manufacturers have collected a significant amount of data.

EPA should also require TSCA section 8(d) reporting by industry of all unpublished health and safety studies on PFAS. EPA should then systematically review all published and unpublished data on these PFAS chemicals to determine whether the agency should require additional testing to fill data gaps. To obtain missing information, EPA should issue testing orders under Section 4 that would require industry to provide analytical methods, physico-chemical properties data, information on fate and transport, ecotoxicity and health effects data, and bio-monitoring and environmental monitoring studies. TSCA section 8(e) reports should also be used as an important source of toxicity information. Once this information is provided by industry, EPA would make it publicly available to support regulation by states or EPA under air, water, and solid waste statutes.

EPA must begin requiring industry to submit chemical standards for their PFAS chemicals and to submit or develop analytical methods on individual PFAS. EPA must accelerate its efforts to develop both PFAS mixture analytical methods and mixture toxicity assessments for all key media. Mixture methods should include TOF to identify the presence of the carbon-fluorine bond, TOPA to reveal the presence of any perfluorinated carboxylic acid (PFCA) or perfluorosulfonic acid (PFSA) precursors by oxidative conversion, and non-targeted gas chromatograph mass spectrometer analyses to identify all compounds present. Mixture methods should also include the Particle-Induced Gamma-Ray Emission (PIGE) spectroscopic method currently used to detect fluorine on the surface of materials if researchers are successful in modifying it to detect fluorine in water and soil.

Preventing the Introduction of New PFAS and New Uses of Existing PFAS
Commercializing new PFAS and new uses of existing PFAS should be prohibited under TSCA because allowing these activities would magnify PFAS exposure and environmental release at a time when the priority should be to reduce risks.

EPA should issue guidance outlining data requirements for PFAS PMNs that are comprehensive and provide a basis for issuing orders under TSCA Section 5 prohibiting introduction of new PFAS pending completion of testing and review of the results. EPA should also announce that it is no longer approving applications to exempt new PFAS from PMN requirements. PMN exemption rules provide EPA authority to reject exemption applications for substances that may present risks to health and the environment and, because of the serious concerns raised by PFAS as a class, no new PFAS should be eligible for expedited approval under these rules.

We now have a much higher level of concern about the risks posed by PFAS than when new PFAS were previously reviewed under the PMN program. It is clear that the data requirements imposed in section 5(e) orders allowing short-chain PFAS to be manufactured were inadequate to prevent public health risks and that these orders insufficiently restricted manufacture, use, and disposal of these substances. EPA should review existing section 5(e) orders for PFAS and update them if not sufficiently health protective, especially for susceptible populations. EPA's failure to require adequate restrictions on GenX before its commercial introduction is a clear example of the inadequacy of the current new chemical review process. The hundreds of PMN exemptions previously granted for PFAS should also be reviewed and revoked or modified where warranted.

To prevent new uses of existing PFAS, EPA should first focus on chemicals that are "inactive" on the TSCA Chemical Substance Inventory because they are no longer being manufactured or processed in the U.S. EPA should promulgate SNURs for all inactive PFAS in order to prevent resumption of manufacture and use without providing the agency advance notice and an opportunity to restrict or prohibit new uses. In addition, similar SNURs should be developed for all discontinued uses of PFAS (short chain and long chain) that are "active.". The upcoming TSCA section 8(a) rule should be valuable in identifying uses of PFAS that are not now occurring.

Eliminating Non-Critical Uses of Existing PFAS
The quickest way to eliminate non-critical uses of existing PFAS would be for Congress to pass legislation banning uses that do not meet the TSCA section 6(g) definition of "critical or essential use." TSCA defines a "critical or essential use" as one for which: 1) no technically and economically feasible safer alternative is available, taking into consideration hazard and exposure; 2) restriction would significantly disrupt the national economy, national security or critical infrastructure; or 3) this use, compared to reasonably available alternatives, provides a substantial benefit to health, the environment, or public safety. EPN believes these criteria can be used effectively to differentiate between non-critical uses that should be banned and critical uses that should be allowed subject to restrictions to protect health and the environment.

In the absence of such legislation, the new PFAS Action Plan should commit EPA to using its existing authority to stop or restrict non-critical uses through the TSCA three-step process of prioritization, risk evaluation, and risk management. EPA should use its authority under TSCA section 26(c) to treat PFAS as a "category" for purposes of implementing this process. Under section 26(b)(2), "category" treatment is warranted if chemicals are "similar in molecular structure, in physical, chemical or biological properties, or in mode of entrance into the human body or into the environment" or "in some other way are suitable for classification as such for purposes of this Act." PFAS meet these criteria because of their similarities in persistence, mobility, and toxicity and the potential for all PFAS to cause the same adverse effects as well-characterized compounds such as PFOA and PFOS.

Thus, EPA would have a sound basis to list the entire PFAS category (or appropriate subcategories) as high priority under section 6(b(1), triggering the next step in the TSCA process, conducting a risk evaluation under section 6(b)(4) to determine whether the category presents an unreasonable risk of injury to health and the environment. This determination would not require an assessment of toxicity and exposure for each category member, but could be based on available data for representative PFAS that would then be applied to other chemicals in the category based on their common characteristics and similar conditions of use, exposure, and environmental release.

Following a determination of unreasonable risk, EPA would be required by TSCA to conduct a risk management rulemaking for the category under section 6(a). TSCA authorizes a broad range of risk management options, including prohibition of manufacture and importation and a ban on all or some uses. These remedies would likely be warranted for PFAS as "necessary" to assure that they no longer present an unreasonable risk, as specified in TSCA section 6(a). EPA could conclude that any more limited restrictions would not be effective in preventing the accumulation of PFAS in people and wildlife, their mobility and distribution in the environment, and their harmful health and environmental effects.

Under TSCA section 6(g), EPA has the ability to grant critical use exemptions as part of its risk management rulemaking. As discussed above, the section 6(g) criteria for critical uses are well-constructed and appropriate for identifying PFAS uses that serve important functions warranting exemption from a general ban on the PFAS category. Such exemptions would need to have time limits and other conditions to protect health and the environment. EPN recommends that EPA consider the need for temporary exemptions from risk management on a sector-by-sector basis, allowing for an orderly review of the various functions served by PFAS within the sector, the availability of alternatives, and the economic and environmental profile of each alternative.

EPN recognizes that many states have demonstrated leadership in addressing concerns about PFAS and have moved toward restrictions on uses of PFAS based on a class approach. It is critical not to stifle state initiative and innovation. If states can move more quickly than EPA to ban or restrict non-critical uses of PFAS chemicals, EPA should grant waivers from state preemption while the agency is conducting the risk evaluation and risk management process for the PFAS category. Section 18(f) of TSCA provides a mechanism for granting such waivers. EPA's risk management rules would then apply only to states lacking laws banning or restricting non-critical uses that provide protection equal to or greater than the federal requirements.

Preventing Exposures to Legacy or Existing PFAS in the Environment

In order to prevent the public's exposure to legacy or existing PFAS in the environment, EPA's new PFAS Action Plan should incorporate a broad multi-media strategy that quickly results in coordinated action across the agency's statutes for surface water, drinking water, air emissions, waste management, and remediation. This strategy should identify the most efficient ways to identify and regulate PFAS discharges to air, water, and land. A key goal will be to evaluate whether a single rule requiring multiple industries to control PFAS releases to the environment can be promulgated or whether individual rules must be developed for each industry sector.

Surface Water Discharges: EPA already has adequate data to prove that the water solubility of PFAS chemicals allows them to pass untreated through most municipal wastewater treatment processes. PFAS chemicals have been found in both the effluent and biosolids of municipal wastewater plants. In fact, some of these plants have been found to have higher effluent PFAS concentrations than influent concentrations due to the formation of short- and long-chain PFAS from precursor compounds within the plant. EPA should take action as soon as possible under the CWA to prevent Publicly Owned Treatment Works

(POTWs) from accepting PFAS contaminated wastewater from industries and contaminated leachate from landfills by setting national pretreatment standards.

EPA should also initiate a Targeted National Sewage Sludge Survey (TNSSS) to assess the prevalence of PFAS chemicals in biosolids in order to determine if there should be a moratorium on applying biosolids to agricultural land. The last TNSSS conducted was in 2009 and did not include PFAS. EPA should also update the national biosolids rule to require testing for PFAS chemicals.

In addition, EPA must accelerate monitoring and setting limits on PFAS in wastewater that industries discharge directly into surface waters. Under the CWA, technology-based permit limits on both indirect and direct dischargers can be promulgated as effluent limitation guidelines, but these guidelines have always been designed individually for each industry sector. EPA should evaluate if PFAS effluent limitation guidelines can be promulgated for multiple industry sectors at the same time. EPA must also recommend that whenever the states or EPA require PFAS monitoring in wastewater permits, they also require TOF measurements in order to support the development of statistical relationships between PFAS chemicals and TOF so eventually inexpensive TOF measurements could substitute for expensive PFAS measurements.

While promulgating technology-based permit limits for point sources under the effluent limitation guideline program, EPA must also develop human health and aquatic life water quality criteria for PFAS chemicals. These water quality criteria are needed to determine if the technology-based limits adequately protect human health and aquatic life or if more stringent water quality-based limits are needed. Water quality criteria are also needed to evaluate the impact of nonpoint sources of PFAS chemicals on human health and aquatic life.

EPA should investigate whether water quality criteria can be developed for mixtures of PFAS chemicals or only for individual PFAS chemicals based on currently available data. If currently available data are not adequate to support a mixtures approach, EPA should initiate data collection to support this approach. In addition, EPA should investigate whether water quality criteria for TOF concentrations can be developed as an indicator for PFAS chemicals, just as *E. coli* and *Enterococcus* water quality criteria were developed as indicators of harmful viruses and pathogens. EPA used monitoring data to identify the relationship between *E. coli*/*Enterococcus* and harmful bacteria/viruses and then established water quality criteria for *E. coli* and *Enterococcus* to avoid developing criteria for each individual harmful virus and bacteria. TOF water quality criteria could similarly be used to establish water quality-based permit limits for wastewater discharges without requiring water quality criteria for each individual PFAS chemical to be developed if EPA could demonstrate the relationship between TOF and PFAS. EPA must also revise the agency's National Aquatic Resource Surveys (NARS) to gather the data needed to support the development of mixtures of PFAS and TOF water quality criteria and work with the U.S. Geological Survey to ensure their PFAS monitoring program is designed to gather the same data.

Drinking Water Protection: To educate the public and provide technical support to states and utilities on PFAS concentrations of concern in drinking water, EPA should use its authority under the Safe Drinking Water Act (SDWA) to propose and finalize drinking water health advisories for PFAS chemicals or mixtures as soon as toxicity assessments are completed. It has taken far too long to begin development of drinking water standards for PFOS and PFOA, and other PFAS have not yet been identified for possible regulation under the SDWA despite the large number of PFAS contaminants found in drinking water by states, federal agencies, universities, and private groups.

In addition, because the rulemaking process under SDWA is lengthy and cumbersome, EPA should consider using its emergency authority for "urgent threats to public health" to promulgate an interim national primary drinking water regulation for PFAS after consultation with the Secretary of Health and Human Services. Under this emergency authority, EPA could promulgate an interim regulation as an Maximum

Contaminant Level (MCL) or as a treatment technique. An interim national drinking water MCL for PFAS mixture could be based on EPA methods 533 and 537.1 plus TOPA/TOF. An interim national drinking water treatment technique could be based on granular activated carbon (GAC) or reverse osmosis and the same analytical methods as for the MCL approach. If EPA chooses instead to only regulate certain specific PFAS, it should at a minimum establish standards as expeditiously as possible for those PFAS chemicals and mixtures with completed toxicity assessments.

When finalizing the 2021 proposed Unregulated Contaminant Monitoring Rule 5 (UCMR 5), EPA should add TOF to the list of compounds monitored in order to support the development of statistical relationships between PFAS chemicals and TOF. EPA should also reevaluate the minimum detection limits required for the PFAS chemicals in UCMR 5, which are considerably higher than the limits commercial laboratories currently achieve and may significantly underestimate the risks of PFAS in the nation's drinking water.

Air Emissions: Air emissions from facilities manufacturing or using PFAS are a significant contributor to human exposure, particularly in communities located near these facilities. Title III of the CAA provides several mechanisms for controlling emissions that have no application to PFAS because these substances are not listed as hazardous air pollutants (HAPs). EPA can change this by designating PFAS as a class as HAPs and then developing technology-based (and if necessary health-based) emission control standards. These standards could be developed for individual industry sectors (the traditional EPA approach) or for a combination of sectors together. EPA should also standardize air TOF and TOPA methods to monitor whether PFAS chemicals reform after emission from a stack.

Waste Management: To ensure the safe disposal of PFAS chemicals under RCRA, EPA should evaluate whether it is more efficient to list specific waste sources as hazardous or to list a group of PFAS chemicals as hazardous. Once these sources or chemicals are listed as hazardous, EPA will be required to promulgate land disposal restrictions within six months of the final listing. Safe storage of these hazardous wastes will also be regulated under RCRA. Since all RCRA hazardous wastes are considered CERCLA hazardous wastes, a RCRA rulemaking designating PFAS as hazardous would eliminate the need for a CERCLA rulemaking.

In addition to bringing PFAS wastes into RCRA's hazardous waste inventory, EPA should look closely at existing hazardous wastes to see if some contain PFAS compounds. The current treatment of those PFAS constituents under EPA's land disposal restrictions program may not be effective, as EPA has recognized in its recent interim PFAS destruction/disposal guidance. One example of this may be some granular GAC wastes that meet RCRA's definition of hazardous waste and also contain PFAS compounds. The carbon regeneration process or the process of treating and then disposing of GAC may result in unintended releases of PFAS to the land, air, surface water, or groundwater.

Finally, EPA should look at the waste management system comprehensively to ensure that as part of waste management, PFAS are not being passed from one media to the next but are being permanently destroyed. In addition to looking at its Subtitle C program, EPA should examine the application of its federal Subtitle D authorities broadly. One possible action would be to add PFAS compounds to the federal municipal solid waste landfill (MSWL) regulations at 40 CFR 258, Appendix I. This list of compounds is part of the detection monitoring program required for groundwater at MSWLs. Given the data that have shown the prevalence of PFAS compounds in MSWL leachate, this would be a prudent and useful update of those regulations. EPA should also investigate PFAS levels in leachate at construction and development landfills to determine if they pose a threat to wastewater treatment plants.

EPA's draft Interim PFAS Destruction and Disposal Guidance documented the serious risks that are posed by every one of the destruction/disposal approaches currently available but did not recommend what should be done given these risks. EPA should revise this guidance to recommend the safe storage of all PFAS materials that are amenable to storage as an interim approach until safe destruction/disposal methods can be identified. Once rulemaking is complete to designate PFAS wastes as hazardous under RCRA, the storage of these wastes will be subject to RCRA hazardous waste requirements.

Until that rulemaking is complete, EPA should recommend the use of RCRA's hazardous waste safe storage practices for PFAS wastes. EPA should recommend that unused aqueous film forming foam (AFFF) be safely collected and warehoused, pursuant to standards that protect against inadvertent use or release. In addition to issuing this guidance, EPA should publicly discourage the landfilling, incinerating, deep well injection, or export of PFAS wastes until the pending analyses of alternate treatment and disposal methods have been completed, and publicly discourage the interim storage of PFAS wastes in environmental justice communities. EPA will need to work closely with the DoD since most AFFF is owned by DoD. EPA should also accelerate the study of safe destruction/disposal approaches by building on the Strategic Environmental Research and Development Program's work on PFAS and by focusing on innovative practices currently under development (e.g., 374Water Clean Solution's Supercritical Water Oxidation technology, which has been shown to effectively destroy PFAS chemicals).

Remediation: Despite the need to use the federal cleanup program to remediate sites with PFAS contamination, CERCLA authorities do not now apply to these sites because no PFAS are listed as CERCLA hazardous substances. The Trump EPA issued an ANPR on possibly designating PFOS and PFOA as hazardous substances under CERCLA; EPA must now move quickly to finalize these designations. EPA must then address the application of CERCLA to other PFAS chemicals. To ensure that responsible parties pay to clean up PFAS contamination of the air, water, and land, EPA should designate groups of PFAS chemicals as hazardous under CERCLA. PFAS chemicals could be grouped by industry sector or by structural/functional similarities for this hazardous substance designation. The first step should be to propose designation of all the long-chain PFAS chemicals as hazardous substances under CERCLA. EPA should also revise the PFAS groundwater cleanup guidance to include GenX and PFBS and to include an emergency removal value for all chemicals covered by the guidance.

Filling Important Gaps in Scientific Understanding

As noted above, numerous gaps in knowledge are impeding effective regulation of PFAS and preventing impacted communities and health professionals from understanding the health and environmental effects of historical and ongoing PFAS exposure. It is imperative that the new PFAS Action Plan include a comprehensive strategy for developing the necessary scientific tools and technologies for developing and implementing regulations. These include validated analytical methods for detecting and measuring many more PFAS in the environment as well as treatment technologies and destruction/disposal methods required to limit environmental releases and address widespread contamination of surface water, drinking water, groundwater, and soil. In addition, there is a pressing need for data to understand the physical-chemical properties of more PFAS, their fate and transport in the environment, their effects on aquatic organisms and wildlife, and the human health effects of individual PFAS and mixtures to which large populations are exposed through products and environmental contamination. Current EPA research efforts under the existing Plan are seriously deficient in meeting these needs.

Support for scaling up research, testing, and technology development requires a mix of enhanced federal funding and stepped-up investment by industry. A currently unutilized tool is Section 4 of TSCA, under which EPA can issue testing orders or rules directing manufacturers to develop analytical methods for both individual chemicals and mixtures as part of their responsibility to monitor for PFAS in waste streams, waterbodies, and biota. TSCA Section 4 orders can also be used to require industry to conduct the animal

and human testing needed to assess the toxicity of PFAS chemicals and mixtures and understand the health effects of prolonged past and continuing exposure by "at risk" communities.

A template for using TSCA Section 4 authorities for these purposes is embodied in the October 2020 TSCA Section 21 petition filed in North Carolina to require Chemours to conduct comprehensive health and environmental effects PFAS testing. The Trump administration's January 7, 2021, denial of the petition was unjustified and should be reversed by the Biden EPA, as recently requested by the petitioners. The agency should then extend the approach in the petition to other PFAS with widespread exposure attributable to particular products or manufacturing operations. In designing testing orders, EPA should recognize the importance of animal testing for human health assessment and revisit the previous administration's directive to "reduce its requests for, and our funding of, mammal studies by 30 percent by 2025 and eliminate all mammal study requests and funding by 2035." *In vitro* and high-throughput assays may provide useful insights and assist in prioritization but are not currently a reliable tool for determining PFAS-identified health effects.

Beyond TSCA testing orders, EPA should investigate ways for EPA to obtain industry funding commitments for research, testing, and technology development. One promising approach would be to use an organization like the independent non-profit Health Effects Institute to conduct research and testing supported by joint EPA and industry funding, a model that has been used successfully for air pollution research.

Broaden Cross-Agency Collaboration

The new PFAS Action Plan should also establish an agency-wide PFAS Task Force to perform the following functions: 1) oversee implementation of the new Plan; 2) track global efforts that address PFAS chemicals; 3) coordinate with other federal agencies addressing PFAS contamination; 4) communicate publicly the prevalence and risks of PFAS chemicals in the U.S.; 5) seek guidance from EPA's National Environmental Justice Advisory Committee (NEJAC), EPA's Children's Health Protection Advisory Committee (CHPAC), and the White House Environmental Justice Advisory Council (WHEJAC); and 6) provide technical assistance to communities with PFAS contamination. Efforts to coordinate with other federal agencies like CDC and NIEHS with overlapping programs are also essential.

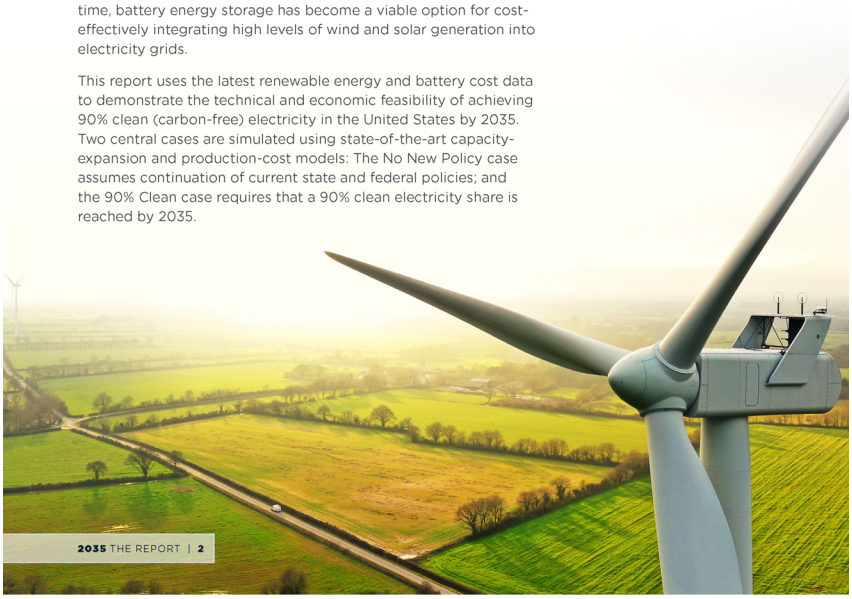

GOLDMAN SCHOOL
OF
PUBLIC POLICY
UNIVERSITY OF CALIFORNIA BERKELEY
2035
THE REPORT
JUNE 2020
PLUMMETING
SOLAR, WIND, AND
BATTERY COSTS CAN
ACCELERATE OUR
CLEAN ELECTRICITY
FUTURE

EXECUTIVE SUMMARY

Global carbon emissions must be halved by 2030 to limit warming to 1.5°C and avoid catastrophic climate impacts. Most existing studies, however, examine 2050 as the year that deep decarbonization of electric power systems can be achieved—a timeline that would also hinder decarbonization of the buildings, industrial, and transportation sectors.

In light of recent trends, these studies present overly conservative estimates of decarbonization potential. Plummeting costs for wind and solar energy have dramatically changed the prospects for rapid, cost-effective expansion of renewable energy. At the same time, battery energy storage has become a viable option for cost-effectively integrating high levels of wind and solar generation into electricity grids.

This report uses the latest renewable energy and battery cost data to demonstrate the technical and economic feasibility of achieving 90% clean (carbon-free) electricity in the United States by 2035. Two central cases are simulated using state-of-the-art capacity-expansion and production-cost models: The No New Policy case assumes continuation of current state and federal policies; and the 90% Clean case requires that a 90% clean electricity share is reached by 2035.



KEY FINDINGS

Table ES-1 shows the report's findings at a glance, and the following discussion expands on these findings.

	CURRENT GRID (2019)	NO NEW POLICY (2035)	90% CLEAN (2035)
Highly Decarbonized Grid	●	●	●
Dependable Grid	●	●	●
Electricity Cost Reductions	-	●	●
Feasible Scale-Up	-	●	●
Highest Number of Jobs Supported	-	●	●
Largest Environmental Savings	-	●	●

TABLE ES-1.

U.S. Power System Characteristics by Case Modeled in the Report

STRONG POLICIES ARE REQUIRED TO CREATE A 90% CLEAN GRID BY 2035

The 90% Clean case assumes strong policies drive 90% clean electricity by 2035. The No New Policy case achieves only 55% clean electricity in 2035 (Figure ES-1). A companion report from Energy Innovation identifies institutional, market, and regulatory changes needed to facilitate the rapid transformation to a 90% clean power sector in the United States.

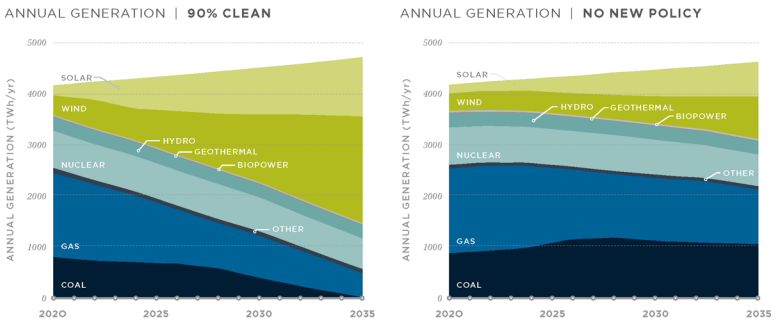


FIGURE ES-1.

Generation Mixes for the 90% Clean Case (left) and No New Policy Case (right), 2020–2035

THE 90% CLEAN GRID IS DEPENDABLE WITHOUT COAL PLANTS OR NEW NATURAL GAS PLANTS

Retaining existing hydropower and nuclear capacity (after accounting for planned retirements), and much of the existing natural gas capacity combined with new battery storage, is sufficient to meet U.S. electricity demand dependably (i.e., every hour of the year) with a 90% clean grid in 2035. Under the 90% Clean case, all existing coal plants are retired by 2035, and no new fossil fuel plants are built. During normal periods of generation and demand, wind, solar, and batteries provide 70% of annual generation, while hydropower and nuclear provide 20%. During periods of very high demand and/or very low renewable generation, existing natural gas, hydropower, and nuclear plants combined with battery storage cost-effectively compensate for mismatches between demand and wind/solar generation. Generation from natural gas plants constitutes about 10% of total annual electricity generation, which is about 70% lower than their generation in 2019.

ELECTRICITY COSTS FROM THE 90% CLEAN GRID ARE LOWER THAN TODAY'S COSTS

Wholesale electricity costs, which include the cost of generation plus incremental transmission investments, are about 10% lower in 2035 under the 90% Clean case than they are today, mainly owing to low renewable energy and battery costs (Figure ES-2). Pervasiveness of low-cost renewable energy and battery storage across the United States requires investment mainly in transmission spurs connecting renewable generation to existing

high-capacity transmission lines or load centers. Hence, additional transmission-related costs and siting conflicts are modest. Relying on natural gas for only 10% of generation avoids large investments for infrequently used capacity, helping to avoid major new stranded-asset costs. Retaining natural gas generation averts the need to build excess renewable energy and long-duration storage capacity—helping achieve 90% clean electricity while keeping costs down. While still lower than today's costs, wholesale electricity costs are 12% higher under the 90% Clean case than under the No New Policy case in 2035. However, this comparison does not account for the value of emissions reductions or job creation under the 90% Clean case.

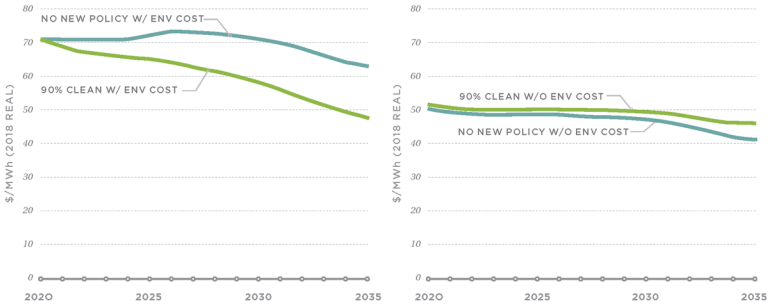


FIGURE ES-2.

Wholesale Electricity Costs with (left) and without (right) Environmental Costs, for the 90% Clean and No New Policy Cases

THE 90% CLEAN GRID AVOIDS $1.2 TRILLION IN HEALTH AND ENVIRONMENTAL DAMAGES, INCLUDING 85,000 PREMATURE DEATHS, THROUGH 2050

The 90% Clean case nearly eliminates emissions from the U.S. power sector by 2035, resulting in environmental and health benefits largely driven by reduced mortality related to electricity generation (Figure ES-3). Compared with the No New Policy case, the 90% Clean case reduces carbon dioxide (CO_2) emissions by 88% by 2035. It also reduces exposure to fine particulate ($PM_{2.5}$) matter by reducing nitrogen oxide (NO_x) and sulfur dioxide (SO_2) emissions by 96% and 99%, respectively.[1] As a result, the 90% Clean case avoids over $1.2 trillion in health and environmental costs, including 85,000 avoided premature deaths, through 2050. These savings equate roughly to 2 cents/kWh of wholesale

1 Primary $PM_{2.5}$ emissions reductions are not estimated by the model, resulting in a conservative estimate of reduced $PM_{2.5}$ exposure.

electricity costs, which makes the 90% Clean case the lowest-net-cost option when environmental and health costs are considered.

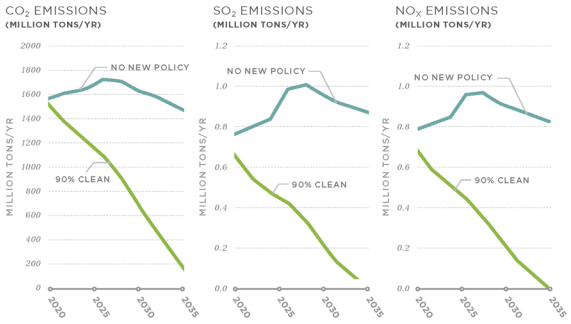


FIGURE ES-3.

Emissions of CO_2, SO_2, and NO_x in the 90% Clean and No New Policy Cases, 2020–2035

SCALING-UP RENEWABLES TO ACHIEVE 90% CLEAN ENERGY BY 2035 IS FEASIBLE

To achieve the 90% Clean case by 2035, 1,100 GW of new wind and solar generation must be built, averaging about 70 GW per year (Figure ES-4). Recent U.S. precedents for natural gas and wind/solar expansion suggest that a renewable energy buildout of this magnitude is challenging but feasible. New renewable resources can be built cost-effectively in all regions of the country.

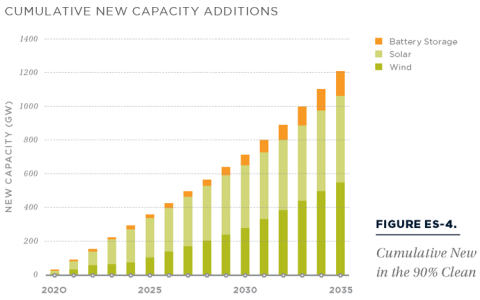


FIGURE ES-4.

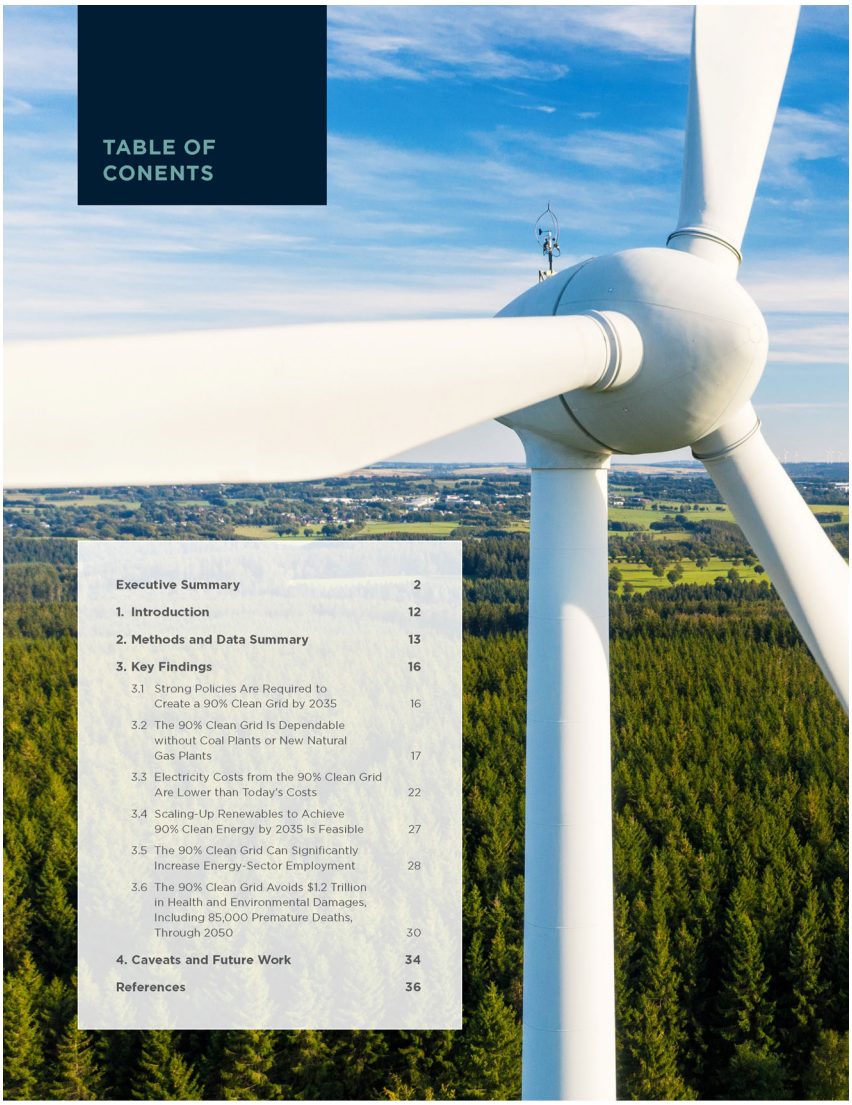
Cumulative New Capacity Additions in the 90% Clean Case, 2020–2035

THE 90% CLEAN GRID CAN SIGNIFICANTLY INCREASE ENERGY-SECTOR EMPLOYMENT

The 90% Clean case supports a total of 29 million job-years cumulatively during 2020–2035. Employment related to the energy sector increases by approximately 8.5 million net job-years, as increased employment from expanding renewable energy and battery storage more than replaces lost employment related to declining fossil fuel generation. The No New Policy case requires one-third fewer jobs, for a total of 20 million job-years over the study period. These jobs include direct, indirect, and induced jobs related to construction, manufacturing, operations and maintenance, and the supply chain. Overall, the 90% Clean case supports over 500,000 more jobs each year compared to the No New Policy case.

ACCELERATING THE CLEAN ENERGY FUTURE

Establishing a target year of 2035, rather than the typical 2050 target, helps align expectations for power-sector decarbonization with climate realities while informing the policy dialogue needed to achieve such an ambitious goal. Aiming for 90% clean electricity—rather than 100%—by 2035 is also important for envisioning rapid, cost-effective decarbonization. By 2035, emerging technologies such as firm, low-carbon power should be mature enough to begin to replace the remaining natural gas generation as the nation accelerates toward 100%, cross-sector decarbonization. Reaching 90% zero-carbon electricity in the United States by 2035 would contribute a 27% reduction in economy-wide carbon emissions from 2010 levels.



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We are thankful to the National Renewable Energy Laboratory for making its ReEDS model publicly available, as well as all their scenarios and the Annual Technology Baseline.

Appendices, supporting reports, and data visualizations can be found at **2035report.com**

GOLDMAN SCHOOL OF PUBLIC POLICY
UNIVERSITY OF CALIFORNIA BERKELEY

GridLAB

ABOUT UNIVERSITY OF CALIFORNIA BERKELEY GOLDMAN SCHOOL OF PUBLIC POLICY

The Center for Environmental Public Policy, housed at UC Berkeley's Goldman School of Public Policy, takes an integrated approach to solving environmental problems and supports the creation and implementation of public policies based on exacting analytical standards that carefully define problems and match them with the most impactful solutions.

ABOUT GRIDLAB

GridLab is an innovative non-profit that provides technical grid expertise to enhance policy decision-making and to ensure a rapid transition to a reliable, cost-effective, and low-carbon future.

1 INTRODUCTION

In October 2018, the U.N. Intergovernmental Panel on Climate Change (IPCC) reported that global carbon emissions must be halved by 2030 to limit warming to 1.5°C and avoid catastrophic climate impacts (UN IPCC 2018). Most existing studies, however, examine 2050 as the year that deep decarbonization of electric power systems can be achieved—a timeline that would also hinder decarbonization of the buildings, industrial, and transportation sectors through electrification.[2] These studies offer little hope that climate change impacts can be held to a manageable level in this century.

Yet, in light of recent trends, these studies—even those published in the past few years—present overly conservative estimates of decarbonization potential. Plummeting costs and cost projections for wind and solar energy have dramatically changed the prospects for rapid, cost-effective decarbonization (Figure 1). At the same time, battery energy storage has become a viable option for cost-effectively integrating high levels of wind and solar generation into electricity grids.

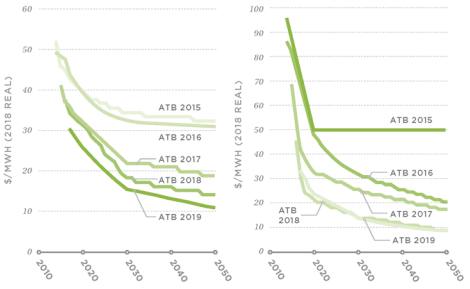


FIGURE 1.

National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB) Low-Case Cost Projections Made 2015–2019 for Years Through 2050

Wind (left) and solar photovoltaic (PV, right) levelized cost of electricity (LCOE) projections are shown by the year that each projection was made in the NREL ATB (NREL 2015; 2016; 2017; 2018; 2019) using ATB low-case assumptions and best capacity factors. LCOE projections were revised downwards in almost every year during this period.

2 Broadly, these studies do not assess near-complete power-sector decarbonization (80% decarbonization or greater) before 2050. The one study (MacDonald et al. 2016) that assesses complete decarbonization of the U.S. power sector by 2030 does not assume a significant role for battery storage, as our report does. Instead, it relies on expansion of the U.S. transmission network, which is technically and economically challenging (Joskow 2004). See Appendix 1 for a brief review of some of these studies.

2 METHODS AND DATA SUMMARY

This report uses the latest renewable energy and battery cost information to demonstrate the technical and economic feasibility of achieving 90% "clean" electricity in the United States by 2035—much more quickly than projected by most recent studies. Generation from any resource that does not produce direct carbon dioxide (CO_2) emissions is considered clean in this analysis, including generation from nuclear, hydropower, wind, solar,[3] biomass, and fossil fuel plants with carbon capture and storage. Consideration of the accelerated 2035 timeframe helps align expectations for power-sector decarbonization with climate realities while informing the policy dialogue needed to achieve such an ambitious goal. This report's target of 90% clean electricity (rather than 100%) by 2035 is also important for envisioning decarbonization at a pace more rapid than considered in previous studies. Achieving almost-complete power sector decarbonization in 2035 may ultimately increase the speed and cost-effectiveness of pervasive, cross-sector decarbonization.

After a brief description of methods and data, the key findings of the 2035 decarbonization report are summarized. The report's appendices provide details of the analyses and results. A companion report from Energy Innovation identifies institutional, market, and regulatory changes needed to facilitate the rapid transformation to a 90% clean power sector in the United States (Energy Innovation 2020).

We performed power-sector modeling in consultation with a technical review committee consisting of experts from utilities, universities, and think tanks. We employed state-of-the-art models, including NREL's Regional Energy Deployment System (ReEDS) capacity-expansion model and Energy Exemplar's PLEXOS electricity production-cost model, in conjunction with publicly available generation and transmission datasets. Forecasts of renewable energy and battery cost reductions were

3 The terms "solar" and "PV" are used interchangeably in this report, because essentially all the solar deployed in the simulations is PV; the concentrating solar power deployment is negligible.

based on NREL's ATB 2019 (NREL 2019).[4] We used these data and methods to analyze two central cases:

- **No New Policy:** Assumes current state and federal policies and forecasted trends in technology costs.[5]
- **90% Clean:** Requires a national 90% clean electricity share by 2035.

We analyzed the sensitivity of the 90% Clean case to periods of extraordinarily low renewable energy generation and/or high demand, to ensure that a system with 90% renewable energy supply meets demand in every hour. To assess system dependability, defined as the ability to meet power demand in every hour of the year, we simulated hourly operation of the U.S. power system over 60,000 hours (each hour in 7 weather years). For each of these hours, we confirmed that electricity demand is met in each of the 134 regional zones (subparts of the U.S. power system represented in the model) while abiding by several technical constraints (such as ramp rates and minimum generation) for more than 15,000 individual generators and 310 transmission lines. Further work is needed to assess issues such as the effect of the 90% Clean case on loss of load probability, system inertia, and alternating-current transmission flows.

We also considered three primary sets of future renewable energy and battery storage cost assumptions (Figure 2; see Appendix 2 for in-depth cost analyses):

- **Low-Cost:** NREL ATB low-case assumptions, assuming 40% to 50% cost reductions for PV, wind, and storage by 2035 (compared with 2020).
- **Base-Cost:** modified NREL ATB mid-case assumptions, assuming 2021 costs begin at the ATB low-case assumptions, but post-2021 cost reductions are in line with the ATB mid-case.
- **High-Cost:** NREL ATB mid-case assumptions, including assumed 2020 costs that are higher than actual 2020 costs.

Appendix 3 details our additional scenario and sensitivity analyses, including a case that seeks to internalize the societal costs of CO_2 emissions. We also evaluated the impact of electrification using the high electrification case from the NREL Electrification Futures Study 2018 (Mai 2018).

4 The cost reductions detailed in this report refer primarily to utility-scale PV, wind, and battery storage. Distributed PV is considered in this analysis, serving as an input to the ReEDS model based on NREL modeling assumptions. In 2035, under the 90% Clean case, there are approximately 60 GW of distributed PV, representing approximately 2% of total energy generation. For detail on the renewable capacity breakdown, see Appendix 3.

5 ReEDS considers relevant state and federal policies, such as state Renewable Portfolio Standards, as of early 2019.

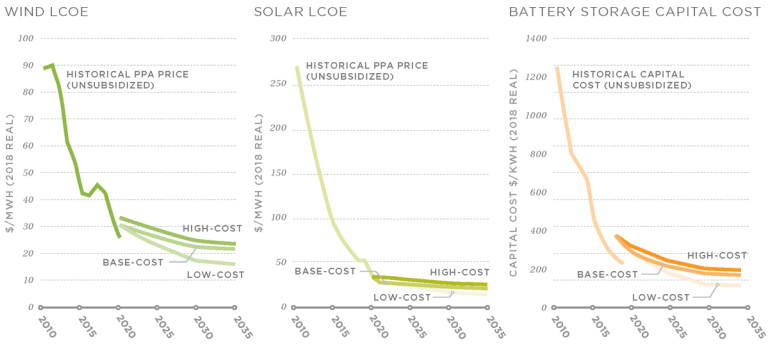


FIGURE 2.

Historical and Projected Technology Cost Declines on Which Our Analyses Were Based

For solar and wind, the historical LCOE was estimated by adjusting historical power-purchase agreement (PPA) prices for subsidies (investment tax credit and production tax credit). PPA price data were obtained from Lawrence Berkeley National Laboratory's utility-scale solar (Bolinger et al. 2019a, 2019b) and wind (Wiser and Bolinger 2019) reports. For four-hour batteries, historical pack costs were based on Bloomberg New Energy Finance data (Goldie-Scot 2019), and balance-of-system cost data were from NREL (2018a). Future cost projections for all three technologies were based on NREL (2019).

We tested the robustness of our findings through sensitivity analyses of the key input assumptions used in this report, including sensitivities around technology costs, financing costs, and natural gas prices. We considered three primary sets of future renewable energy and battery storage technology costs (described above), two sets of financing costs, and two sets of natural gas prices. The base case financing costs correspond to the assumptions used in NREL (2019) and are in line with today's financing costs. The high financing costs assume that the cost of capital (real) is twice the cost assumed in the base case. The base case natural gas prices are the same as in the reference case in the U.S. Energy Information Administration (EIA) Annual Energy Outlook (EIA 2020a). The low natural gas prices use New York Mercantile Exchange (NYMEX) future prices until 2023, and beyond 2023 the price of natural gas is kept constant at $2.50/MMbtu (nominal), with a floor of $1.50/MMbtu (2018 real). We evaluate all permutations of these assumptions for the No New Policy and 90% Clean cases (24 cases in total). Refer to Appendix 3 for further sensitivity analyses.

We used the industry-standard IMPLAN model to estimate the job losses and gains associated with each of our cases. We used ReEDS to estimate emissions—CO_2 as well as sulfur dioxide (SO_2) and nitrogen oxides (NO_x)—associated with power generation based on emission factors for each generation technology. We used estimates of the social cost of carbon and damages associated with SO_2 and NO_x from the literature (as dollars and premature deaths per metric ton of pollutant) to estimate the environmental damages associated with each case. Results and assumptions are discussed below and in Appendix 2.

3
KEY FINDINGS

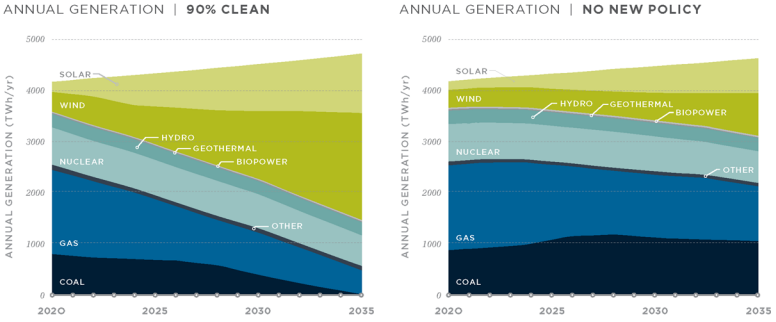
This section highlights the key findings from our analysis. Additional details are provided in the appendices.

3.1 STRONG POLICIES ARE REQUIRED TO CREATE A 90% CLEAN GRID BY 2035

In our 90% Clean case, we require a 90% clean electricity share by 2035; that is, we set the 2035 grid mix to be 90% clean. In this analysis, clean generation refers to resources that produce no direct CO_2 emissions, including hydropower, nuclear, wind, PV, and biomass. In the No New Policy case, however, the grid mix is determined by least-cost capacity-expansion modeling based on the current paradigm for electricity-market costs, which does not fully internalize the costs of environmental and health damages from fossil fuel use. As a result, clean generators only supply 55% of the electricity in the No New Policy case in 2035. Figure 3 compares the grid mixes in the two cases. The 2035 grid mix from EIA's Annual Energy Outlook Reference Case is similar (47% clean generation) to the 2035 mix in the No New Policy case (EIA 2020a).

FIGURE 3.

Generation Mixes for the 90% Clean Case (left) and No New Policy Case (right), 2020–2035



The 90% Clean case assumes implementation of policies that promote large-scale renewable energy adoption and yield net societal benefits compared with the business-as-usual approach assumed under the No New Policy case. As detailed in Sections 3.3 and 3.6, the nominal electricity cost increases under the 90% Clean case are more than offset by the societal benefits provided by that case.

3.2 THE 90% CLEAN GRID IS DEPENDABLE WITHOUT COAL PLANTS OR NEW NATURAL GAS PLANTS

Given the dramatic decline in battery storage prices, we find that significant short-duration storage is cost-effective and plays a critical load in balancing the grid. We estimate that about 600 GWh (150 GW for 4 hours) of storage cost-effectively supports grid operations in the 90% Clean case, representing about 20% of daily electricity demand.[6] When renewable energy generation exceeds demand, storage can charge using this otherwise-curtailed electricity and then dispatch electricity during periods when renewable generation falls short of demand. Despite the addition of storage, about 14% of available renewable energy must be curtailed annually. New long-duration storage technologies might reduce curtailment further.

To estimate the generation capacity required to meet system demand in every hour, even during periods of low renewable energy generation and/or high demand, we simulate hourly operation of the U.S. power system for more than 60,000 hours (each hour in 7 weather years). For each of these hours, we evaluate and confirm how electricity demand is met in each of the 134 regional zones (subparts of the U.S. power system represented in the model) while abiding by several technical constraints (such as ramp rates and minimum generation) for more than 15,000 individual generators and 310 transmission lines.

During the 7 weather years, we find significant variation in wind and solar generation. During the hour of lowest wind and solar generation, total wind and solar generation is 94% below rated capacity (about 75 GW of generation from 1,220 GW of capacity) and 80% below the yearly average of wind and solar generation. Solar generation drops to zero in nighttime hours, whereas the lowest hourly period of wind generation is about 90% below

6 Because of modeling limitations, we only consider a 4-hour storage duration in this analysis.

average. The decline in wind and solar generation over days and weeks is progressively lower (Figure 4).

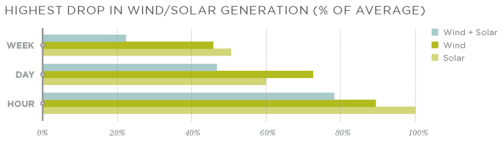


FIGURE 4.

Maximum Drop in Wind and Solar Output Relative to Average Wind and Solar Generation

To highlight the dependability of a 90% clean electricity grid and estimate natural gas capacity requirements, we identify the period during the 7 weather years when maximum natural gas generation capacity is needed to compensate for the largest gap between clean electricity generation (including battery generation) and load. The maximum natural gas capacity required is about 360 GW on August 1 in one of the weather years (2007) (Figure 5). At 8:00 pm Eastern Time on that day, solar generation declines to less than 10% of installed solar capacity, while wind generation is 18% below installed wind capacity, resulting in only about 150 GW of wind and solar production (about 55% below the annual average, as indicated in Figures 6 and 7). The total system demand of about 735 GW is met by a combination of other clean resources, such as hydropower and nuclear, approximately 360 GW of natural gas, and 80 GW of battery discharge (Figure 8).

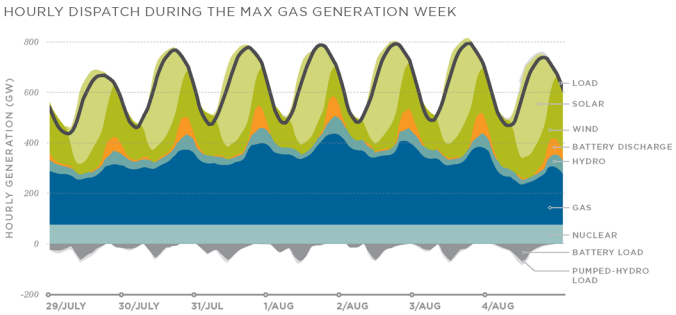


FIGURE 5.

Hourly U.S. Power-System Dispatch for Extreme Weather Days in the 90% Clean Case in 2035

Figure 5 details the dispatch for the period of maximum natural gas generation, one week in late July and early August. Approximately 360 GW of natural gas is dispatched to meet demand on August 1, while renewables contribute significantly less generation than normal. Even when wind and solar generation drops to low levels, existing hydropower, nuclear power, and natural gas capacity, as well as new battery storage, are sufficient to maintain system operations.

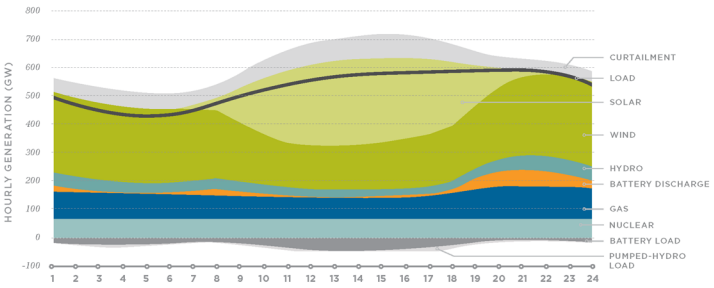


FIGURE 6.

Hourly U.S. Power-System Dispatch for an Average Weather Day in the 90% Clean Case in 2035

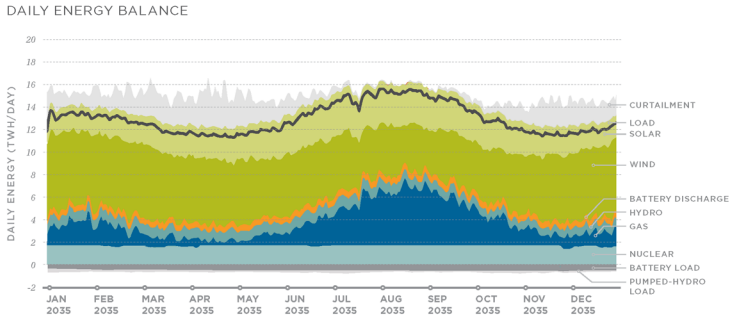
Figure 6 details the annual average generation stack for each hour of an average weather day. Wind and solar provide a large share of nighttime and daytime generation, respectively, and broadly complement each other. Battery storage is primarily dispatched during evening hours when solar generation drops and load remains relatively high.

For all weather years, the natural gas capacity requirements are highest in August, when wind generation falls significantly (Figures 7 and 8). Natural gas generation above 300 GW is required for fewer than 45 hours per year over the 7-weather-year simulation. Of the 360 GW of natural gas dispatch in 2035 under the 90% Clean case, 70 GW has a capacity factor below 1%. Other technology alternatives not considered in this analysis, such as demand response, energy efficiency, or flexible load, may be more cost-effective for system balancing in those hours.

We also find that increased electrification of the U.S. economy reduces the amount of battery storage required, and results in slightly lower wholesale power costs than the 90% Clean Case (see Appendix 3).

FIGURE 7.

Daily U.S. Power System Dispatch Averaged Over 7 Weather Years in the 90% Clean Case in 2035



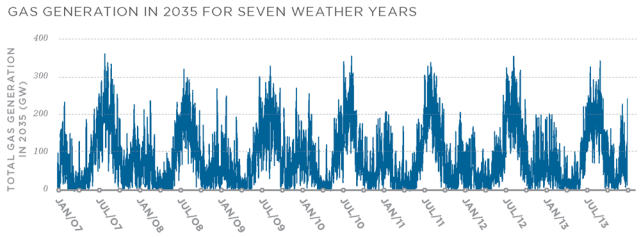


FIGURE 8.

Hourly U.S. Natural Gas Dispatch over 7 Weather Years in the 90% Clean Case in 2035

Figure 8 details the hourly natural gas generation in 2035 for 7 weather years. The maximum natural gas generation required is 360 GW.

The renewable energy variation we observe over the 7-year period is similar to the variation observed over a 35-year period by Shaner et al. (2018), although they may underestimate the variation in wind generation compared to that seen in our data, as Shaner et al. considers significantly lower spatial resolution than our study. Our analysis does not consider 35 weather years owing to lack of data. Further, our simulation includes adequate natural gas and battery storage capacity to meet residual load (load minus clean energy generation) that is up to 113% of average load and 70% of peak load. Hence, even if a longer period of weather data reveals larger gaps between load and wind/solar generation, additional firm capacity requirements are unlikely to be significant. However, further work is needed to assess this possibility.

In summary, retaining existing hydropower capacity and nuclear power capacity (after accounting for planned retirements) and about half of existing fossil fuel capacity, combined with 150 GW of new 4-hour battery storage, is sufficient to meet U.S. electricity demand with a 90% clean grid in 2035, even during periods of low renewable energy generation and/or high demand. Under the 90% Clean case, all existing coal plants are retired by 2035, and no new fossil fuel plants are built beyond those already under construction. During normal periods of generation and demand, wind, solar, and batteries provide 70% of total annual generation, while hydropower and nuclear provide 20%. During periods of high demand and/or low renewable generation, existing natural gas plants (primarily combined-cycle plants) cost-effectively compensate for remaining mismatches between demand and renewables-plus-battery generation—accounting for about 10% of total annual electricity generation, which is about 70% lower than their generation in 2019.

Although the capacity-expansion modeling (ReEDS) required that clean resources contribute 90% of annual generation in 2035, the hourly operational model (PLEXOS) simulated roughly 85% clean generation, primarily due to higher curtailment of wind and solar. PLEXOS model dispatch decisions were based on the variable cost of generation and did not consider the carbon free or non-carbon free nature of the generation source.

In an electricity market with a 90% clean energy constraint, as modeled in our 90% Clean Case, clean energy may bid negative prices in certain hours in order to get dispatched and meet the 90% constraint. We utilize ReEDS to effectively model this 90% clean electricity share, while the main purpose of our simulation in PLEXOS is to evaluate operational feasibility. For this reason, we did not simulate the same 90% clean energy constraint in

PLEXOS, which might have required clean energy to bid negative prices in order to get dispatched.[7]

Our modeling approach represents a conservative strategy for achieving 90% clean energy. Various complementary approaches could help achieve this deep decarbonization, with potential for even lower system costs and accelerated emissions reductions. Demand-side approaches include demand response and flexible loads, such as flexible electric vehicle charging and flexible water heating—which could play a large role if building and vehicle electrification occurs more rapidly than envisioned in our core cases. Flexible load could similarly take advantage of zero or negatively priced electricity that is likely to occur during the hours of curtailment, which will likely increase the overall clean energy share. New supply-side resources, such as firm low-carbon generation or longer-duration storage, could also provide system flexibility. Firm, low-carbon resources could include electricity generation from gases (such as hydrogen or methane) produced via excess clean electricity, small modular nuclear reactors, long-duration storage, or other emerging technologies. Such alternative approaches to balancing generation and demand could cost less than retaining significant natural gas capacity that is rarely used.

3.3 ELECTRICITY COSTS FROM THE 90% CLEAN GRID ARE LOWER THAN TODAY'S COSTS

Wholesale electricity (generation plus incremental transmission) costs are lower in 2035 under the 90% Clean case than they are today (Figure 9).[8] The base wholesale electricity cost under the 90% Clean case is 4.6 cents/kWh, about 10% lower than the 5.1 cents/kWh in 2020. Wholesale costs in the 90% Clean case in 2035 are 4.2–5.6 cents/kWh across all cost sensitivities. The only sensitivity case in which those costs are marginally (10%) higher than costs in 2020 assumes both high technology costs and high financing costs (see Appendix 3 for details). Lower wholesale costs would translate into lower retail electricity prices, assuming electricity distribution costs do not change significantly in the 90% Clean case.[9]

7 The fact that PLEXOS curtails more clean energy generation than ReEDS is primarily due to two factors: 1) ReEDS does not have the full set of real system constraints; and 2) we are not modelling a clean energy constraint or negative bid prices in PLEXOS.

8 Costs include recovery of capital costs from new and existing generation capacity, fixed operations and maintenance costs, fuel and variable operations and maintenance costs, and new transmission (bulk and spurline) investments. The cost figures referenced throughout this report refer to the total wholesale generation costs plus the cost of additional transmission investments beyond 2019.

9 We assume distribution costs do not rise faster than inflation in the next 15 years. Because the 90% Clean case does not rely heavily on distributed energy resources, this is a reasonable assumption. Distributed PV serves as an input to the ReEDS model based on NREL's distributed generation model. In 2035, under the 90% Clean case, there are approximately 60 GW of distributed PV, representing approximately 2% of total energy generation.

These findings are similar to the findings of power-system studies conducted in the past 1–2 years, but the clean power system target date for most of those studies is 15 years later than 2035 (Jayadev et al. 2020, Bogdanov et al. 2019). Our findings contrast sharply with the findings of studies completed more than 5 years ago, which show future electricity bills rising compared to today's bills. For example, NREL's Renewable Electricity Futures Study, published in 2012, projected retail electricity price increases of about 40%–70% above 2010 prices, for a system with 90% renewable electricity penetration in 2050 (NREL 2012). Renewable energy and battery costs have declined much faster than these older studies assumed, which is the main reason their cost results differ so much from ours.

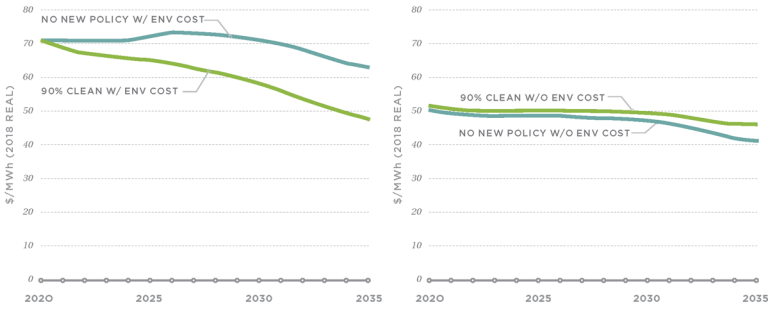


FIGURE 9.

Wholesale Electricity Costs (Costs of Generation and Incremental Transmission) with (left) and without (right) Environmental (Air Pollution and Carbon Emissions) Costs, for the 90% Clean and No New Policy Cases

If environmental costs are included, wholesale electricity costs are about 33% lower in 2035 under the 90% Clean case than they are in 2020, and they are 25% lower in 2035 under the 90% Clean case than they are in 2035 under the No New Policy case. Without considering environmental costs, wholesale electricity costs are 10% lower in 2035 under the 90% Clean case than they are in 2020, but they are 12% higher in 2035 under the 90% Clean case than they are in 2035 under the No New Policy case.

Low renewable energy and storage costs are the primary reason that electricity costs decline under the 90% Clean case. Section 2 shows the dramatic national renewable energy and storage cost trends. Figure 10 illustrates that these competitive costs become available throughout the country, even in regions previously considered resource-poor for renewable energy generation. Our estimates align with some of the recent renewable energy bids seen in relatively resource-poor regions.

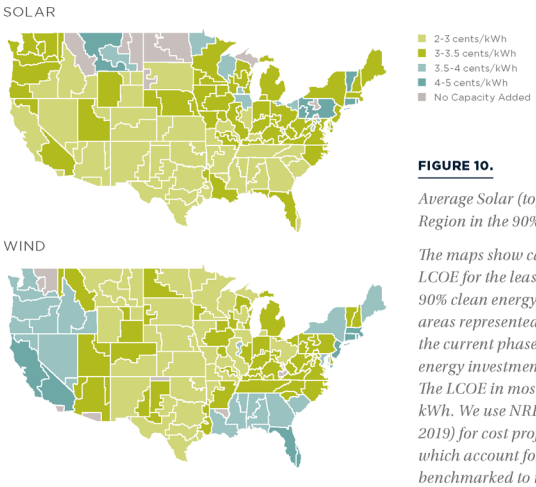


FIGURE 10.

Average Solar (top) and Wind (bottom) LCOE by Region in the 90% Clean Case in 2035

The maps show capacity-weighted average LCOE for the least-cost portfolio to meet the 90% clean energy target for the 134 balancing areas represented in ReEDS. LCOE includes the current phase-out of the federal renewable energy investment and production tax credits. The LCOE in most zones is lower than 3.5 cents/kWh. We use NREL's 2019 ATB Mid-Case (NREL 2019) for cost projections with some modifications, which account for the cost reductions already benchmarked to recent PPA pricing.

Under the 90% Clean case, most transmission investments are in new spurline transmission rather than bulk transmission (Figure 11).[10] Although the 90% Clean case requires about three times more spurline investment than the No New Policy case does, the total transmission requirements in the 90% Clean case add only 0.2 cents/kWh to total system costs.[11] Recent studies that account for low renewable energy and storage costs have similar findings (Jayadev et al. 2020). Studies that assume much higher renewable energy costs or do not consider storage find higher levels of additional bulk transmission required (Clack et al. 2017, NREL 2012).[12] Further work is needed to understand transmission needs more precisely.

10 Spurline transmission refers to lines needed to connect remote renewable energy generation to the bulk transmission system or load centers. Bulk transmission refers to larger, higher-capacity transmission lines designed to carry electricity across long distances at high voltages, typically above 115 kV.

11 Construction of spurline transmission is likely less complex than construction of bulk transmission, because spurline transmission typically does not cross multiple jurisdictions.

12 We assessed a scenario with higher renewable energy and storage costs based on NREL ATB 2015 (NREL 2015) and found that significant additional bulk transmission is cost-effective, suggesting that—when renewable energy and battery costs are high—significant new bulk transmission is useful. However, when those costs are low, as modeled in the 90% Clean case, limited new bulk transmission investments are necessary.

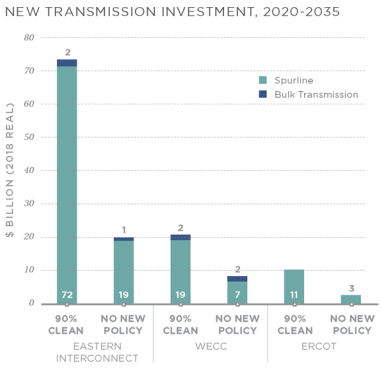


FIGURE 11.

Additional Spurline and Bulk Transmission Investments by Interconnect under the 90% Clean and No New Policy Cases, 2020–2035

The vast majority of transmission investments are spurline investments as opposed to bulk transmission system investments. Total transmission investments add only 0.2 cents/kWh to system costs in the 90% Clean case. ERCOT = Electric Reliability Council of Texas, WECC = Western Electricity Coordinating Council.

Low electricity costs in the 90% Clean case are also facilitated by the limited use of fossil fuel generators; all coal plants are retired by 2035, and no new natural gas plants are built (see Section 3.2). Thus, the 90% Clean case avoids large amounts of fuel and large investments in generating capacity that is used infrequently. In addition, using a 2035 target year provides sufficient time for existing fossil assets to recover most of their fixed costs and thus avoids significant stranded-asset costs. Of the approximately 1,000 GW of U.S. fossil fuel generation capacity operating today, 800 GW will be at least 30 years old in 2035 (Figure 12) (Jell 2017). At this time, a high percentage of the coal and older natural gas units will be fully depreciated (given the usual depreciation life of 30 years or less) and can be retired at little or no cost to consumers and minimal stranded costs.[13] For coal plants with significant undepreciated balances, securitization of these balances through government- or ratepayer-backed bonds can yield significant savings and reduce financial hardship for asset owners, as discussed in an accompanying report from Energy Innovation (Energy Innovation 2020).

13 We define stranded cost as the cost of fossil assets that are not used but have not been fully depreciated, assuming a depreciation life of 30 years. From a market standpoint, this applies only to assets that are built and operated by utilities. Assets that operate under a PPA or are merchant power plants cannot be considered stranded from a market perspective. See the accompanying report from Energy Innovation for further discussion of stranded assets (Energy Innovation 2020).

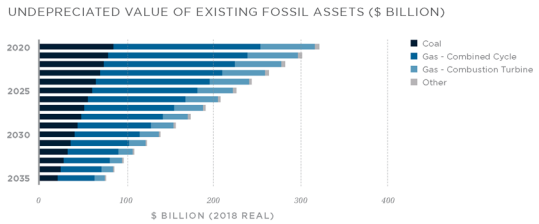


FIGURE 12.

Undepreciated Value of Existing U.S. Fossil Fuel Capacity, 2020–2035

By 2035, the remaining undepreciated value of fossil fuel generating plants is minimal, suggesting a transition to 90% clean energy can be accomplished with minimal stranded assets.

Conversely, using existing natural gas capacity to meet about 10% of electricity demand avoids the need to build excess renewable energy and long-duration storage capacity—helping accelerate the timeline for 90% clean electricity while keeping costs down. Further decarbonization could then build on this mostly clean electricity system; several pathways to 100% clean electricity have been identified. See Appendix 1 for a brief literature review on many of these analyses.

Although electricity costs are lower in 2035 under the 90% Clean case than they are today, they are 0.46 cents/kWh (12%) higher than they are under the No New Policy case in 2035 (Figure 9). However, this comparison does not account for the value of carbon emissions and air pollutant reductions, which make the societal costs of electricity substantially lower under the 90% Clean case than they are under the No New Policy case (see Section 3.6). In addition, the 90% Clean case supports additional jobs in the electricity sector compared with the No New Policy case (Section 3.5). Finally, significant natural gas capacity is built under the No New Policy case, which likely will result in future stranded costs, whereas no new fossil fuel capacity is built under the 90% Clean case.[14]

14. If there still are a few coal units owned by regulated utilities that, in 2035 (or at time of retirement) have undepreciated life-extension or pollution-control capital costs, those can be retired at low cost using a securitization mechanism. This approach has been used in recent years by large investor-owned and public utilities to create a positive return for shareholders and downward pressure on wholesale and retail electricity prices (Lehr and O'Boyle 2018).

3.4 SCALING-UP RENEWABLES TO ACHIEVE 90% CLEAN ENERGY BY 2035 IS FEASIBLE

To achieve the 90% Clean case by 2035, 1,100 GW of new wind and solar generation must be built, averaging about 70 GW per year (Figure 13). For comparison, the size of today's U.S. power sector is approximately 1,000 GW. Although challenging, a renewable energy buildout of this magnitude is feasible with the right supporting policies in place. For example, 65 GW of U.S. natural gas generation were built in 2002 (Ray 2017).

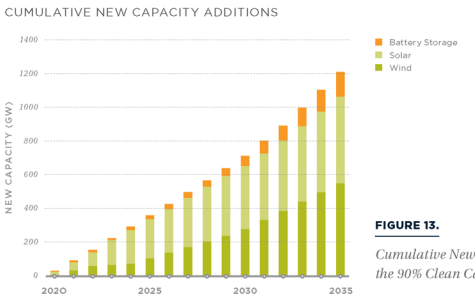


FIGURE 13.

Cumulative New Capacity Additions in the 90% Clean Case, 2020–2035

Historical and planned U.S. renewable energy deployments also suggest that annual deployments of 70 GW are possible. In 2016, 15 GW of PV were installed, and EIA suggests that 19.4 GW of wind will be deployed in 2020 (EIA 2020b). Interconnection queues in the United States currently include 544 GW of wind, solar, and standalone battery storage, roughly half of the 1,100 GW required (Bolinger et al. 2019a, 2019b). Storage, onshore wind, and solar generation generally have shorter construction times compared with natural gas plants, and they do not require a gas pipeline connection. Significant policy support is needed to achieve this level of renewable energy deployment, as highlighted in an accompanying report from Energy Innovation (2020).

New renewable resources can be built cost-effectively in all regions of the country, as indicated by the proliferation of utility-scale renewables nationwide. The top 10 states for installed utility-scale solar represent at least four distinct regions: New England, the Southeast, the West, and the Southwest. More than

75% of U.S. states have one or more utility-scale solar projects (Bolinger et al. 2019a, 2019b). The Midwest, once considered a laggard for utility-scale renewable projects, accounted for the largest percentage of solar added to interconnection queues in 2018 (26%).

3.5 THE 90% CLEAN GRID CAN SIGNIFICANTLY INCREASE ENERGY-SECTOR EMPLOYMENT

The COVID-19 pandemic has taken a heavy human and economic toll. In just 6 weeks, the pandemic wiped out over 40 million American jobs. In a slack labor market, such as the one that Americans may experience in the coming years owing to a contracting economy, a clean energy buildout could be a key part of the economic recovery.

The 90% Clean case supports approximately 29 million job-years cumulatively during 2020–2035. Employment related to the energy sector increases by about 8.5 million job-years as increased employment from expanding renewable energy and battery storage more than replaces lost employment related to declining fossil fuel generation (Figure 14). The No New Policy case requires one-third fewer jobs, for a total of 20 million job-years over the study period. These jobs include direct, indirect, and induced jobs related to construction, manufacturing, operations and maintenance, and the supply chain.[15] In the 90% Clean case, an increase in construction- and manufacturing-related jobs outweighs a smaller decrease in jobs related to operations and maintenance. Fossil fuel power-sector jobs are dominated by fuel handling, operations, and maintenance activity. Solar, wind, and storage plants require less daily maintenance and no fuel handling, but they do require far more labor-intensive construction jobs.[16]

15 A job-year represents one full-time job held for one year.

16 There is uncertainty about where clean energy manufacturing might occur in a 90% Clean case. The employment factors modeled in IMPLAN assume most PV, wind, and battery component manufacturing occurs in the United States. This assumption potentially overstates the resulting domestic jobs in all scenarios; those results should be considered as upper bounds of employment potential. Supporting federal policy can drive employment in these sectors and ensure jobs in manufacturing and the supply chain remain in the United States, as indicated in a supporting report from Energy Innovation (2020).

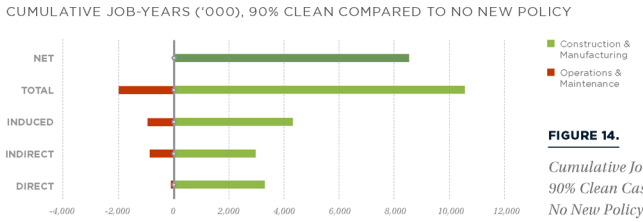


FIGURE 14.

Cumulative Job-Years 2020–2035, 90% Clean Case Compared to the No New Policy Case

Overall, the 90% Clean case supports over 500,000 more jobs each year compared to the No New Policy case. A loss of about 100,000 fossil fuel operations and maintenance jobs is more than offset by growth in wind and solar construction of over 600,000 jobs per year.

The 90% Clean case supports about 1.8 million ongoing jobs, or a total of approximately 29 million job-years from 2020–2035. About 1.1 million jobs, or 18 million job-years, are related to the construction, manufacturing, and supply chain of the electricity system (including induced jobs). The additional 700,000 jobs (11 million job-years) are related to operations and maintenance.

In contrast, the No New Policy case supports approximately 1.3 million ongoing jobs, or 20 million job-years from 2020–2035. Approximately 460,000 ongoing jobs (7.4 million job-years) are related to construction, manufacturing, and supply chain industries, while another 813,000 (13 million job-years) are related to operations and maintenance.

Although economic models such as IMPLAN are useful in determining the upside potential of job creation, the results are only realized through significant policy support. The extraordinary economic downturn resulting from the COVID-19 pandemic presents an opportunity to drive job creation in the near term through accelerated renewable energy deployment. The 2009 American Reinvestment and Recovery Act can serve as a model for effective stimulus spending (Mundaca and Luth Richter 2015).

All regions of the country could experience significant economic activity from local renewable energy generation and storage deployment. However, in some communities, the shift away from fossil fuel generation may disrupt workers and communities that rely on jobs and tax revenue related to fossil

fuel production and power generation. Policies implemented to decarbonize the power sector should include explicit measures to support transitions to a lower-carbon economy. Existing research suggests that wind and PV plants can be built close to many retiring coal plants, helping to provide new economic opportunities in the impacted communities (Gimon et al. 2019). Support for economic redevelopment and diversification beyond the clean energy industry can help more generally with an effective transition from fossil fuels. A supporting report from Energy Innovation highlights key policy drivers to support coal community services, health, and employment during the energy transition (Energy Innovation 2020).

Appendix 4 reports the employment results in detail.

3.6 THE 90% CLEAN GRID AVOIDS $1.2 TRILLION IN HEALTH AND ENVIRONMENTAL DAMAGES, INCLUDING 85,000 PREMATURE DEATHS, THROUGH 2050

The 90% Clean case nearly eliminates emissions from the U.S. power sector by 2035 (Figure 15), resulting in environmental cost savings as well as reduced mortality related to electricity generation. Further, achieving 90% clean electricity by 2035 accelerates benefits in ensuing years, because the No New Policy power system continues to be fossil fuel dependent. We estimate climate-related impacts using a social cost of carbon value, and we estimate human health damages due to NO_x, SO_2, and fine particulate matter ($PM_{2.5}$) emissions using an established method from the literature.[17] Compared to the No New Policy case, in the 90% Clean case CO_2 emissions are reduced by 1,300 million metric tons (88%) through 2035, while NO_x and SO_2 emissions are reduced by 96% and 99%, respectively (Figure 15). See Appendix 4 for details of the analysis.

17 Benefits of reduced greenhouse gas emissions are valued at a social cost of carbon of approximately $50/metric ton (derived from Baker et al. 2019 and Ricke et al. 2018). Avoided air pollution damage estimates for SO_2, NO_x, and $PM_{2.5}$ are based on state-by-state damage factors provided by Maninder Thind based on Thind et al. (2019).

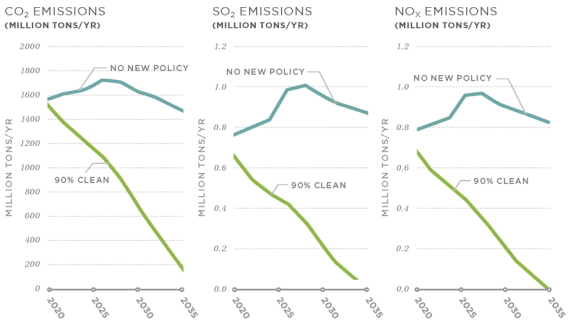


FIGURE 15.

Emissions of CO_2, SO_2, and NO_x in the 90% Clean and No New Policy Cases, 2020–2035

As a result, the 90% Clean case avoids about $1.2 trillion (in 2018 dollars) in environmental and health costs through 2050, including approximately 85,000 premature deaths, largely due to avoided SO_2, NO_x, and CO_2 emissions from coal plants (Figure 16) (Holland et al. 2019).[18] The environmental cost savings from the 90% Clean case roughly equate to 2 cents/kWh of wholesale electricity costs. Avoided premature deaths are primarily because of reduced exposure to $PM_{2.5}$, driven by reductions in SO_2 emissions, a precursor to $PM_{2.5}$, from coal plants.[19] About 60% of the avoided environmental costs are from avoided CO_2 emissions, with the remainder associated with reduced exposure to $PM_{2.5}$.

18 Coal power generation accounted for about 90% of air pollution related premature deaths and about 60% of CO_2 emissions associated with the U.S. power sector in 2019. The marginal environmental damage of coal (which our modeling does not include in our main scenarios) is highly significant (about two times the variable cost of coal). This fact, and the very low capacity factors predicted for coal plants in 2035, led us to assume that all coal power plants retire after 40 years of life (which allows them to recover most of their fixed costs). In 2035, we find that about 10% of the coal capacity will be 40 years old or younger.

19 Primary $PM_{2.5}$ emissions factors are not modeled in ReEDS, and hence our estimate of reduced emissions contributing to reduced $PM_{2.5}$ exposure may be conservative. Based on Thind et al. (2019) and Goodkind et al. (2019), primary $PM_{2.5}$ emissions contribute to roughly 10%–15% of premature deaths due to $PM_{2.5}$ exposure.

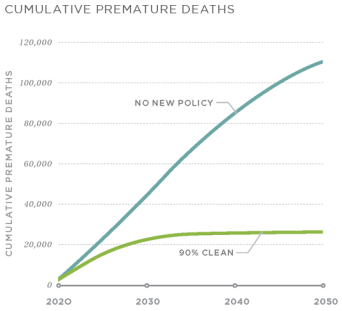


FIGURE 16.

Cumulative Premature Deaths Due to SO_2 and NO_x Pollution, 2020–2050

THE 90% CLEAN CASE AVOIDS ABOUT 85,000 PREMATURE DEATHS BY 2050 RELATIVE TO THE NO NEW POLICY CASE.

These estimates are meant to illustrate the magnitude of some of the societal benefits that may be realized through rapid power-sector decarbonization. However, the environmental and health impacts of electricity use are subject to substantial uncertainties, and differences in input parameters provided by various sources can have large effects on impact calculations (Thind et al. 2019). Our estimate of premature deaths (about 3,500 per year) for the No New Policy case is approximately half the estimate reported in much of the existing literature, suggesting our analysis presents a conservative estimate of premature deaths.[20] Our assumptions regarding the social cost of carbon are based on the lower range of estimates of national social cost of carbon calculations.

Important milestones can be achieved before 2035 as well. This report shows that, by 2030, the United States can reach over 70% zero-carbon electricity on the grid at no additional cost. The IPCC states that global economy-wide emissions must be reduced 45% by 2030 from 2010 levels to limit warming to 1.5° (UN IPCC 2018). Using a 2010 baseline, reaching over 70% zero-carbon electricity in the United States by 2030 would contribute an 18% reduction in U.S. economy-wide emissions, and reaching 90% zero-carbon electricity would contribute a 27% reduction by 2035. This is a meaningful contribution to the overall

20 Estimates of premature deaths cited in Thind et al. (2019) range between 10,000 and 17,050 premature deaths per year.

requirements outlined by the IPCC, and a clean electricity system can help reduce emissions from transportation and buildings via conversion to electric vehicles and appliances.

Refining the estimates of benefits from the 90% Clean case is an important area for future work. Appendix 4 provides analysis of two particular impacts of expanding renewable energy technologies and shrinking fossil fuel generation: reduced water use and increased land use related to electricity generation.

ACHIEVING A 100%-CLEAN U.S. POWER SECTOR

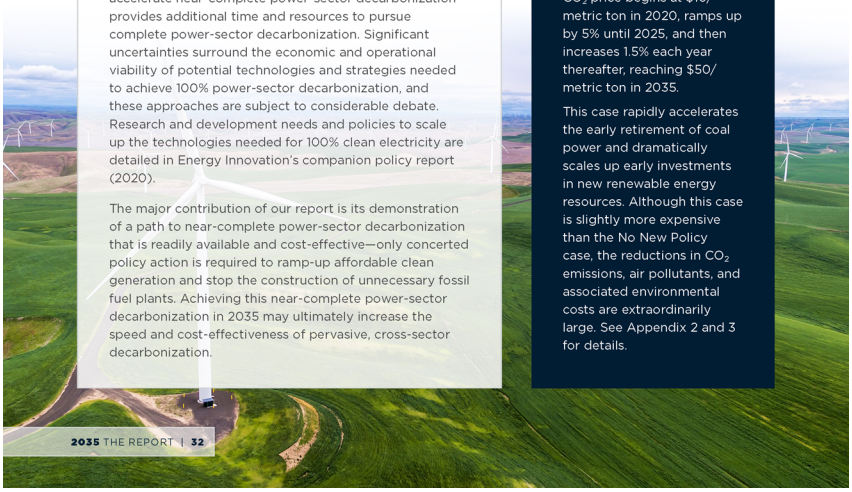
This report's target of 90% clean electricity (rather than 100%) by 2035 is important for envisioning decarbonization at a pace more rapid than considered in conventional policymaking and academic research. The use of currently available, cost-effective technology to accelerate near-complete power-sector decarbonization provides additional time and resources to pursue complete power-sector decarbonization. Significant uncertainties surround the economic and operational viability of potential technologies and strategies needed to achieve 100% power-sector decarbonization, and these approaches are subject to considerable debate. Research and development needs and policies to scale up the technologies needed for 100% clean electricity are detailed in Energy Innovation's companion policy report (2020).

The major contribution of our report is its demonstration of a path to near-complete power-sector decarbonization that is readily available and cost-effective—only concerted policy action is required to ramp-up affordable clean generation and stop the construction of unnecessary fossil fuel plants. Achieving this near-complete power-sector decarbonization in 2035 may ultimately increase the speed and cost-effectiveness of pervasive, cross-sector decarbonization.

SOCIAL COST OF CARBON CASE

We analyze a scenario in which the social costs of CO_2 emissions are embedded into the wholesale generation cost of fossil fuel plants. The CO_2 price begins at $10/metric ton in 2020, ramps up by 5% until 2025, and then increases 1.5% each year thereafter, reaching $50/metric ton in 2035.

This case rapidly accelerates the early retirement of coal power and dramatically scales up early investments in new renewable energy resources. Although this case is slightly more expensive than the No New Policy case, the reductions in CO_2 emissions, air pollutants, and associated environmental costs are extraordinarily large. See Appendix 2 and 3 for details.



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CAVEATS AND FUTURE WORK

Although we assess operational feasibility of the U.S. power system using weather-synchronized load and generation data, further work is needed to advance our understanding of other facets of a 90% clean power system. First, this report primarily focuses on renewable-specific technology pathways and does not explore the full portfolio of clean technologies that could contribute to future electricity supply. Importantly, our modeling approach represents a conservative strategy to achieve 90% clean energy. A number of complementary technologies or approaches could contribute to deep decarbonization, many of which could result in even lower system costs or accelerated emissions reductions. Additionally, issues such as loss of load probability, system inertia, and alternating-current transmission flows need further assessment. Options to address these issues have been identified elsewhere (e.g. Denholm 2020). Although this analysis does not attempt a full power-system reliability assessment, we perform scenario and sensitivity analysis to ensure that demand is met in all periods, including during extreme weather events and periods of low renewable energy generation. This modeling approach provides confidence that a 90% clean electricity grid is operational. Finally, although this report describes the system characteristics needed to accommodate high levels of renewable generation, it does not address the institutional, market, and regulatory changes that are needed to facilitate such a transformation. A supporting report from Energy Innovation identifies many of these solutions (Energy Innovation 2020). Further study limitations and a more robust narrative of detailed results can be found in the appendices.

The 2035 Report details how renewable energy and battery storage costs have fallen to such an extent that, with concerted policy efforts, the U.S. power sector can reach 90% clean energy by 2035 without increasing consumer bills or impacting the operability of the electric grid. In doing so, the U.S. power sector can inject over $1.7 trillion in clean energy investments into the U.S. economy, support employment equivalent to about 29 million job-years cumulatively during 2020–2035, and largely eliminate planet-warming and air pollution emissions from

electricity generation. This 90% clean electricity grid can provide clean, dependable power without the construction of new fossil fuel plants. However, the 90% clean grid cannot be achieved without concerted policy action, and business-as-usual could lead to over $1.2 trillion in cumulative health and environmental damages, including 85,000 premature deaths.

Perhaps most importantly, this report shows that the timeline for near-complete decarbonization of the electric sector can be accelerated from 2050 to 2035. This is critical, because power-sector decarbonization can be the catalyst for decarbonization across all economic sectors via electrification of vehicles, buildings, and industry. Owing to the global nature of renewable energy and battery markets, our report indicates the possibility that cost-effective decarbonization can be a near-term reality for other regions and countries. More research is needed to identify the potential for near-complete decarbonization in the 2035 timeframe in other regions of the world. Such rapid decarbonization, if pursued by other high-emitting jurisdictions worldwide, would increase the likelihood of limiting global warming to 1.5°C.

This report's target of 90% clean electricity (rather than 100%) by 2035 is also important for envisioning decarbonization at a pace more rapid than considered in previous studies. This target allows some existing natural gas generation capacity to be used infrequently to meet demand during periods of low renewable energy generation, which otherwise require major additional investments in renewable energy and energy storage, increasing costs dramatically.

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GOLDMAN SCHOOL
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UNIVERSITY OF CALIFORNIA BERKELEY

2035
THE REPORT

APRIL 2021

TRANSPORTATION

PLUMMETING COSTS AND DRAMATIC IMPROVEMENTS IN BATTERIES CAN ACCELERATE OUR CLEAN TRANSPORTATION FUTURE

1 EXECUTIVE SUMMARY

Global carbon emissions must be halved by 2030 to limit warming to 1.5°C and avoid catastrophic climate impacts. The U.S. transportation sector is the country's largest carbon emitter and a challenging piece of the decarbonization puzzle. Fortunately, recent advances in electric vehicle (EV) battery cost and performance, range, and recharging—along with a proliferation of vehicle models—have readied EVs to overtake gasoline and diesel vehicles as the dominant on-road technology. Now that the plummeting cost of wind and solar power have enabled a rapid and cost-effective expansion of a clean electricity grid, a cost-effective pathway to decarbonize the transportation sector is in reach. Yet electric vehicles make up only a small part of today's U.S. vehicle fleet, and many sales projections for the next decade are modest. Several hurdles, including high upfront vehicle costs and inadequate charging infrastructure, rather than technical or economic feasibility, are the largest barriers to EV sales growth and accelerated decarbonization to align with global climate targets.

In this report, we analyze the economic, human health, environmental, and electric grid impacts of a future in which ground transportation is all-electric. Our main scenario, the Drive Rapid Innovation in Vehicle Electrification (DRIVE Clean) scenario, represents a future in which EVs constitute 100% of new U.S. light-duty vehicle (LDV) sales by 2030 as well as 100% of medium-duty vehicle (MDV) and heavy-duty truck (HDT) sales by 2035. The grid reaches 90% clean electricity by 2035, and substantial EV charging infrastructure is deployed. We compare this scenario to a No New Policy scenario, in which EVs constitute 45% of new LDV sales, 38% of MDV sales, and 12% of HDT sales in 2035, and the clean electricity share reaches only 47% by 2035. By demonstrating that the ambitious DRIVE Clean goals are technically feasible and economically beneficial, we aim to inform broader discussions of the U.S. transportation transition. Following are key findings from our analysis.

CONSUMER SAVINGS FROM EV OWNERSHIP START SOON AND GROW RAPIDLY

Historically, EV sales have been hindered by two consumer-cost disadvantages: the total cost of ownership (TCO) and upfront prices of EVs have both been high in relation to internal combustion engine (ICE) vehicles. Our results show, however, that electric heavy-duty trucks already hold a TCO advantage today, and light-duty EVs will overtake ICE vehicles in TCO terms within 5 years (Figure ES-1). In addition, light-duty EVs will reach upfront price parity with their ICE counterparts in the mid- to late-2020s, while electric HDTs will approach upfront price parity with diesel trucks in the mid- to late-2030s. However, the persistence of high upfront EV costs is a major barrier to achieving rapid decarbonization of the transportation sector. At a national level, the DRIVE Clean scenario yields cumulative economic savings of approximately $2.7 trillion through 2050 compared to the No New Policy scenario — an average household savings of approximately $1,000 per year over the next 30 years. The DRIVE Clean scenario's electrification of light-duty EVs by 2030 is critical to the benefits realized, saving $460 billion more than a scenario in which 100% light-duty EV sales are achieved 5 years later.

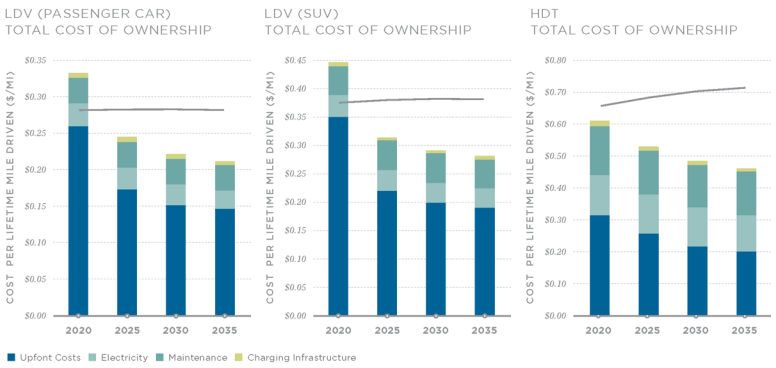

FIGURE ES-1.

TCO for EVs (bars) vs. ICE vehicles (lines), showing TCO parity achieved by 2023 for LDVs (left and center) and an existing TCO advantage for HDTs (right). Upfront costs include taxes. Maintenance costs of EVs include battery replacement cost.

ACCELERATING EV ADOPTION SAVES 150,000 LIVES, AVOIDS $1.3 TRILLION IN HEALTH AND ENVIRONMENTAL DAMAGES THROUGH 2050

Gasoline- and diesel-powered vehicles harm human health and the environment via emissions of pollutants such as fine particulate matter, nitrogen oxides, and sulfur oxides as well as greenhouse gas emissions that contribute to climate change. These emissions disproportionately impact low-income communities and communities of color. Compared with the No New Policy scenario, the total transportation sector pollutant and carbon dioxide (CO_2) emissions reductions in the DRIVE Clean scenario avoid approximately 150,000 premature deaths and equate to nearly $1.3 trillion in health and environmental savings through 2050 (Figure ES-2). The DRIVE Clean scenario slashes ground transportation sector CO_2 emissions by 60% in 2035 and by 93% in 2050, relative to 2020 levels. Total transportation sector emissions fall by 48% in 2035 and by 75% in 2050, relative to 2020 levels (Figure ES-3).

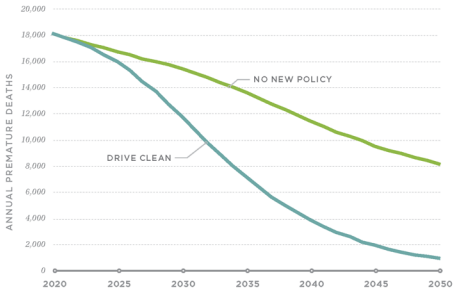

FIGURE ES-2.

Annual premature deaths in the No New Policy and DRIVE Clean scenarios, 2020–2050. The DRIVE Clean scenario avoids 150,000 premature deaths due to air pollution through 2050.

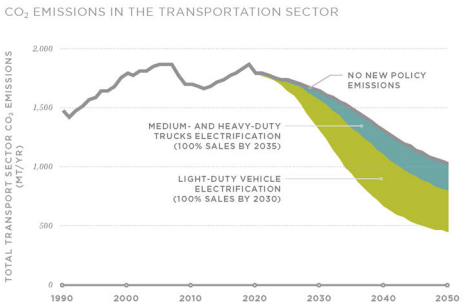

FIGURE ES-3.

Transportation sector CO_2 emissions in the DRIVE Clean and No New Policy scenarios through 2050.

THE ELECTRIC VEHICLE TRANSITION SUPPORTS EMPLOYMENT OPPORTUNITIES ACROSS THE ECONOMY

The DRIVE Clean scenario supports consistent job gains in 2020-2035, peaking at over 2 million jobs in 2035 compared to the No New Policy scenario (Figure ES-4). Employment gradually ramps up in this timeframe as electric vehicle manufacturing expands and the electric grid adds new renewable energy and battery storage resources to support increased vehicle electrification. Consumer cost savings in the transition to electric vehicles similarly increases induced jobs in the economy. While electric vehicles require less maintenance and have fewer parts, the reduction in auto repair jobs is more than offset by gains in economy-wide induced jobs and increased power sector jobs.

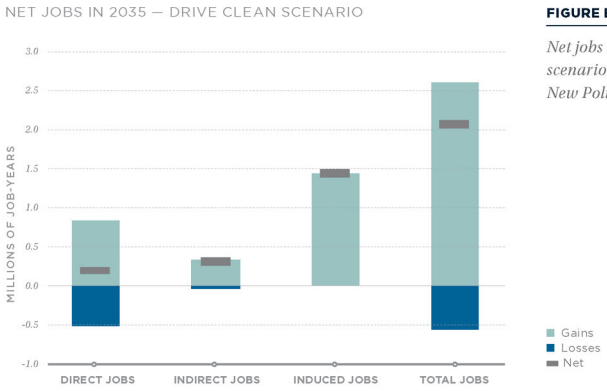

FIGURE ES-4.

Net jobs in 2035, DRIVE Clean scenario compared to the No New Policy scenario.

EV PERFORMANCE AND AVAILABILITY CAN MEET THE NEEDS OF AMERICAN DRIVERS

American drivers have become accustomed to the vehicle performance and availability standards established by gasoline- and diesel-powered vehicles for vehicle range, fueling time, diversity of vehicle models, and—for commercial vehicles—weight. EVs have been improving rapidly across all these dimensions, and our analysis suggests they will not present significant barriers to the accelerated EV deployment envisioned in the DRIVE Clean scenario.

REQUIRED CHARGING INFRASTRUCTURE CAN BE BUILT COST-EFFECTIVELY TO SERVE THE ENVISIONED EV FLEET

To enable the DRIVE Clean scenario, U.S. EV-charging infrastructure must provide drivers with at least as much convenience as provided by existing gasoline and diesel fueling stations. We find that the pace of the required infrastructure scaleup is challenging but achievable, and the costs are modest compared with the benefits of widespread EV deployment. Each year over the next 30 years, the United States must install an average of approximately 270,000 public chargepoints for LDVs and 35,000 MDV/HDT chargepoints. The rate of installation

is comparable to historical rates achieved in other rapidly electrifying regions. The cumulative investment in public charging infrastructure ($6.5 billion per year) makes up a small portion of EV TCO in the DRIVE Clean scenario (Figure ES-1).

GLOBAL AND DOMESTIC SUPPLY CHAINS CAN SATISFY ACCELERATED EV AND BATTERY PRODUCTION, LED BY U.S. COMPANIES

With strong policy support, domestic and global EV manufacturing capacity can sufficiently scale to meet the DRIVE Clean goals. In addition, accelerated U.S. EV deployment will present opportunities for U.S. manufacturing leadership in an increasingly competitive global context. The DRIVE Clean scenario requires that annual U.S. electric LDV sales grow from 331,000 to over 15 million by 2030. Domestic manufacturing of these vehicles is beginning to ramp up, with significant investments from manufacturers such as Ford and General Motors. At the same time, more than 125 zero-emission MDVs and HDTs are in production or development in the United States. Similarly, the DRIVE Clean scenario will depend on at least 1,300 GWh of battery capacity per year by 2035. While current global lithium-ion battery demand is about 300 GWh, global battery manufacturing capacity is expected to exceed 2,000 GWh by 2028. Strong policy will be necessary to further develop domestic vehicle and battery manufacturing capacity, encourage raw material procurement and cost-competitive battery recycling, and help the U.S. compete globally.

ELECTRIC GRID IMPACTS OF THE ENVISIONED EV FLEET ARE MANAGEABLE

Even with additional electric loads in the DRIVE Clean scenario, the 90% clean grid is dependable without coal plants or new natural gas plants by 2035. In addition, the resulting wholesale electricity cost is lower than today's costs. Under the DRIVE Clean scenario, all existing coal plants are retired by 2030, no new fossil fuel plants are built, and electricity demand growth from increased electrification averages about 2% per year, a growth rate slower than that achieved in 1975-2005 (Figure ES-5). To meet this demand, the United States must install on average 105 GW of new wind and solar and 30 GW of new battery storage each year—nearly four times the current deployment rate in the U.S., but lower than that achieved by China in 2020 (Figure ES-6).

During normal periods of demand, the combination of existing hydropower and nuclear capacity, approximately half of existing fossil fuel capacity, and new battery storage, wind, and solar is sufficient to meet load dependably with a 90% clean grid. During periods of high demand and/or low renewable generation, existing natural gas plants (primarily combined-cycle plants) cost-effectively compensate for remaining mismatches between demand and renewables-plus-battery generation—accounting for about 10% of total annual electricity generation. Although new investments in the distribution system are necessary to support increased load from electric vehicles, the costs are modest. Because electricity sales are increasing due to electrification, the increased distribution costs are spread across more units of electricity, which results in lower costs to consumers on a per kWh basis. We do not analyze the benefits of managed or "smart" charging. However, existing literature suggests that EVs can serve as flexible loads, helping to reduce bulk system and distribution system costs.

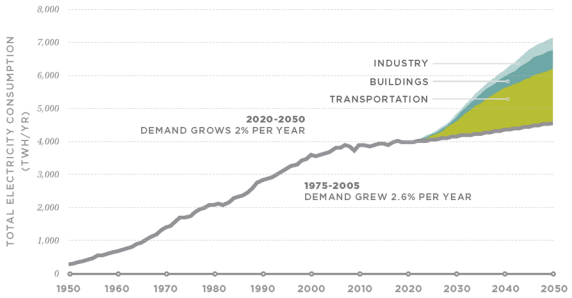

FIGURE ES-5.

Historical and average annual U.S. electricity demand growth in the DRIVE Clean scenario, 2020–2050.

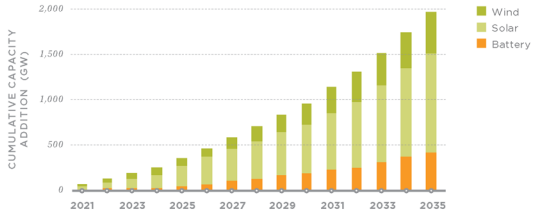

FIGURE ES-6.

U.S. electricity capacity additions in the DRIVE Clean scenario, 2021–2035.

ACCELERATING TRANSPORTATION ELECTRIFICATION: THE CRITICAL ROLE OF A POLICY ECOSYSTEM

Plummeting battery costs, breakthroughs in battery technology, and dramatic declines in clean energy costs have accelerated the timeline for cost-effective transportation decarbonization. Significant barriers remain, but the total consumer cost savings and societal benefits of accelerated vehicle electrification are staggering. Achieving the goal of the DRIVE Clean scenario puts the United States on a 1.5°C pathway for economy-wide decarbonization while yielding substantial human health and environmental benefits and saving consumers $2.7 trillion in vehicle spending—approximately $1,000 in average household savings each year—over the next 30 years. If light-duty vehicle electrification is delayed to 2035 in accordance with many currently proposed transportation electrification goals, we leave significant cost savings on the table. When it comes to electrifying transportation, sooner is definitely better.

New policies and regulations will be needed to achieve the accelerated 100% electric vehicle sales goal. A companion report from Energy Innovation details the policy and regulatory changes that could enable the electric vehicle and charging-infrastructure deployment necessary to equitably decarbonize ground transportation.

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Appendices, supporting reports, and data visualizations can be found at 2035report.com.

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ABOUT GRIDLAB

GridLab is an innovative non-profit that provides technical grid expertise to enhance policy decision-making and to ensure a rapid transition to a reliable, cost-effective, and low-carbon future.

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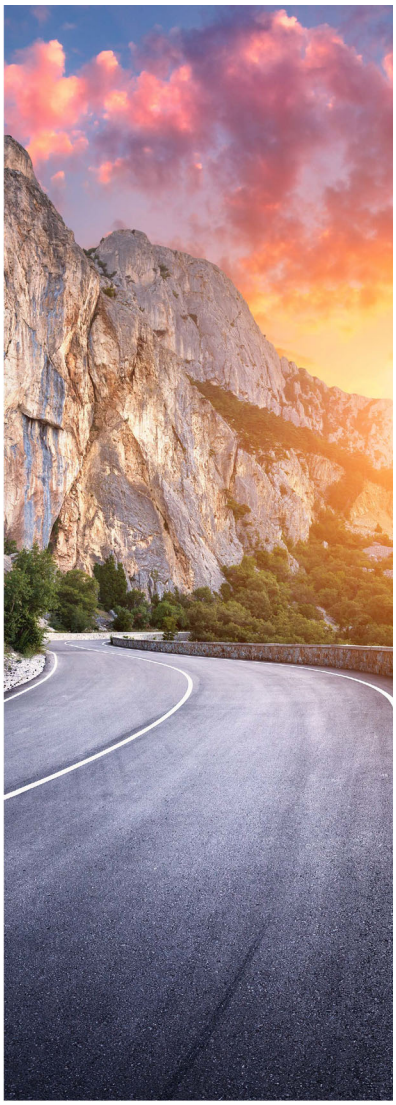
Energy Innovation is a nonpartisan energy and environmental policy firm, delivering high-quality research and original analysis to policymakers to help them make informed choices on energy policy. Energy Innovation's mission is accelerating clean energy by supporting the policies that most effectively reduce greenhouse gas emissions, working closely with policymakers, other experts, NGOs, the media, and the private sector.

2
INTRODUCTION

Global carbon emissions must be halved by 2030 to limit global warming to 1.5°C and avoid the most catastrophic climate impacts. Based on recent analysis by Energy Innovation, zero-emission vehicles must constitute 100% of light-duty vehicle (LDV) sales no later than 2035 to align with a 1.5°C pathway and a safe climate future (Orvis 2021). However, decarbonizing the U.S. transportation sector—the country's largest carbon emitter (Figure 1)—has proven extremely difficult to date. In fact, transportation's greenhouse gas (GHG) emissions have increased 7% since 2010 (EPA 2021). Cars and trucks remain almost entirely dependent on gasoline and diesel fuels, and current U.S. policies are inadequate to achieve a 1.5°C pathway and reduce air pollution emissions that disproportionately impact frontline communities and communities of color.

The transition to zero-emissions vehicles presents unique challenges. Hundreds of millions of Americans own or lease vehicles for personal and business purposes. Each driver relies on a well-established network of refueling stations and maintenance facilities to keep their vehicles operational. Numerous economic, historical, cultural, political, and personal ties bind Americans to their conventional vehicles. The challenges of displacing this fossil-fuel based transportation system hinder the introduction of technologies with potential to improve vehicle performance while reducing costs and environmental impacts—threatening untenable delays in the transition to a clean transportation future.



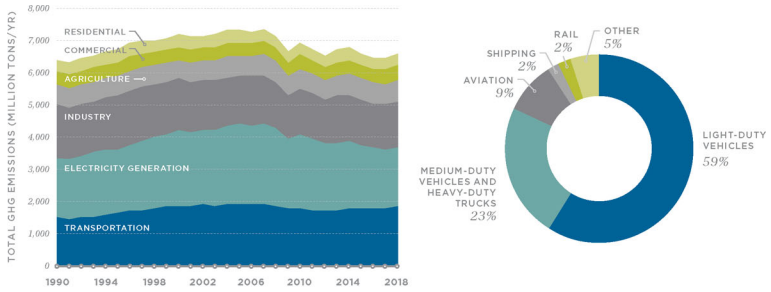


FIGURE 1.

Total U.S. GHG emissions, 1990–2018 (left), and total U.S. transportation GHG emissions, 2018 (right). The transportation sector is responsible for nearly 30% of total economy-wide GHG emissions (EPA 2021). In 2018, on-road vehicles—the focus of this report—were responsible for nearly 84% of transportation emissions. Aviation, shipping, rail, and other transportation categories are not considered in this report (image recreated from EPA 2021).

Electric vehicles (EVs) are the key to rapidly decarbonizing the U.S. transportation sector. Although EV technology dates back to the beginning of the 1900s, recent advances in battery cost and performance, vehicle range, and recharging—along with a proliferation of EV models from automakers and a rapidly expanding network of vehicle chargers—have readied EVs to overtake gasoline and diesel vehicles as the dominant on-road technology, based on economics alone. Most importantly, the price of EV batteries declined 89% between 2010 and 2020 and is conservatively expected to fall 27% more by 2025 (Figure 2).[1] In addition, EVs produce no tailpipe emissions, their high efficiency slashes GHG emissions,[2] and overall emissions disappear as EVs are charged with increasingly carbon-free electricity. In short, electric vehicles are positioned to provide large individual, national, and global benefits in the near term.

1 Battery prices currently average approximately $135/kWh, with lithium ferrous-phosphate (LFP) battery packs priced as low as $100/kWh in China. Battery price projections vary widely owing to the nascent state of the industry, and experts have underpredicted the rapid decline in battery prices over the past few years.

2 Battery-electric motors are four times more efficient than traditional internal combustion engines (ICEs).

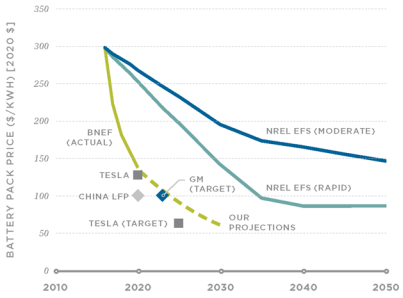


FIGURE 2.

Historical and projected EV battery pack prices, including the price projection used in this report.

Yet EVs[3] made up only 2% of U.S. vehicle sales in 2019, and many sales projections for the next decade are modest. Figure 3 shows a range of passenger EV sales projections through 2030 compiled by Brattle Group, reaching a low of 6% according to the U.S. Energy Information Administration (EIA) to a high of 37% according to one Electric Power Research Institute estimate. In general, these EV sales projections cluster around 12% to 26% in 2030. This is reasonably rapid growth to be sure, but it is wholly inadequate to the task of quickly decarbonizing the U.S. transportation system while reducing consumer costs, improving public health, and ensuring a safe climate future.

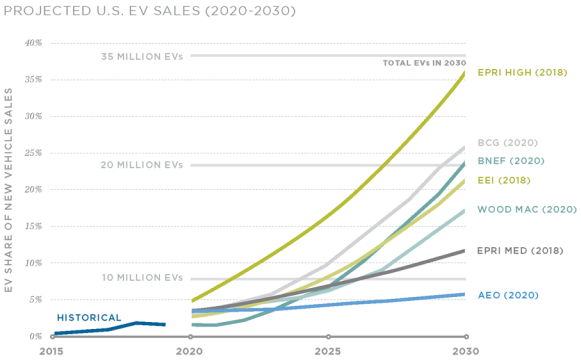


FIGURE 3.

Projected U.S. passenger EV sales, 2020–2030, by various analysts (image recreated from Hagerty 2020).

3 Including battery-electric and plug-in hybrid electric vehicles.

Political will, policy, and consumer acceptance—not technical or economic feasibility—are the largest barriers to beating these EV sales projections. As evidence, we present a scenario in which EVs constitute 100% of U.S. LDV sales by 2030 and 100% of MDV and HDT sales by 2035, while the grid reaches 90% clean electricity by 2035 and substantial charging infrastructure is deployed.[4] This scenario is not a projection, in that we do not estimate future EV sales based on forecasted consumer demand or policy that will drive customer adoption. Rather, we simply set the 100% EV sales levels in the target years. By demonstrating that a more ambitious goal is technically feasible and economically beneficial, this report aims to inform broader discussions of the transportation transition underway in the United States.

Barriers to vehicle electrification exist, and this report does not address how every barrier might be overcome on the path to 100% EV sales by 2035. Rather, it illuminates the total consumer cost savings and societal benefits that could be realized sooner if the United States were to accelerate vehicle electrification. This report also helps inform the level of charging infrastructure deployment, manufacturing capacity, and electric grid deployments needed to enable this ambitious goal. Importantly, total cost of ownership (TCO) is not the sole driver of the individual decision to adopt a new EV, nor does everyone have the ability (or prerogative) to buy a new car. Existing barriers, such as complex purchase incentives or subsidies and lack of charging infrastructure investment in disadvantaged communities, make purchasing an EV particularly challenging for many individuals.

In recognition of extrinsic factors that may impact the 100% EV sales goals, we present a sensitivity analysis in which the light-duty electric vehicle sales target is delayed by 5 years. This analysis highlights the additional costs and emissions associated with achieving 100% electric LDV sales by 2035. Policymakers, countries, states, and automakers are coalescing around this target date. Recent announcements, however, such as Volvo's commitment to sell 100% EVs by 2030, suggest ambition in the EV space is increasing. Accelerating EV sales is particularly important because of the lag time between a sales target and actual vehicle turnover; sales goals must accelerate such that an increasing number of EVs replace ICE vehicles as individual vehicles approach the end of their useful lives (Myers 2019).

4 We do not analyze the costs and benefits of other vehicle decarbonization technologies, such as biofuels or fuel cell vehicles. We believe the current status and prospects for EV technology, along with the prospects for rapidly decarbonizing the U.S. electric grid, give EVs the best chance of decarbonizing vehicle sales in the 2030–2035 timeframe.

Regardless of the 100% electrification target date, new policies and regulations will be needed to achieve the goal. A companion report from Energy Innovation details the policy and regulatory changes that could enable the EV and charging-infrastructure deployment necessary to equitably decarbonize ground transportation (Baldwin et al. 2021). In the remainder of this report, a brief discussion of methods, data, and scenarios is followed by a summary of key findings. The appendix provides more information on the analysis and findings.

3 SCENARIOS, METHODS, AND DATA

This report uses the latest available data to demonstrate the feasibility and impacts of achieving 100% EV sales for all U.S. ground transportation by 2030 (light-duty vehicles) and 2035 (medium- and heavy-duty vehicles). We also assume the electricity grid is operating on 90% clean (carbon-free) electricity by 2035. We run a supporting power-sector analysis to assess the overall impact of both goals on the dependability and functionality of the electric grid.

SCENARIOS

Our analysis evaluates two scenarios:

No New Policy, *a business-as-usual scenario in which fleet electrification proceeds as determined by current market forces without assistance from new state or federal policy.*

This scenario assumes the continuation of existing (2020) state and federal policies and assumes the extant barriers to EV adoption persist, such as underdeveloped charging infrastructure, higher upfront EV price premiums, no widespread adoption of EV-specific electricity rate designs, low levels of consumer awareness and acceptance related to EVs, few policies aimed at addressing equitable access to EVs, and poor accounting for the societal advantages of EVs over conventional vehicles. In this scenario, EVs constitute about 45% of new LDV sales, 38% of new medium-duty vehicle (MDV) sales, and 12% of new heavy-duty truck (HDT) sales in 2035. The scenario is based on projections from Bloomberg New Energy Finance (BNEF), which suggest that—absent policy intervention—ICE vehicles will constitute 46% of the total on-road vehicle population by 2050 (McKerracher 2021). In this scenario, the electric grid decarbonizes based on current state and federal power-sector policy. This business-as-usual approach closely mirrors the projections of the National Renewable Energy Laboratory's (NREL's) standard scenarios, in which the clean electricity (carbon-free) share reaches 47% by 2035 (Cole 2020).

Drive Rapid Innovation in Vehicle Electrification (DRIVE Clean), *which projects that EVs constitute 100% of U.S. LDV sales by 2030 and 100% of MDV and HDT sales by 2035. Figure 4 shows EV sales as percentages of total vehicle sales for the two scenarios.*

The DRIVE Clean scenario assumes new policies are adopted and market forces shift to overcome EV-related barriers quickly. EV sales scale logarithmically to 100% between 2020 and the target year. By 2050, EVs constitute 97% of all on-road vehicles. In this scenario, all coal-fired power plants retire by 2030, no new natural gas plants are built, and the electric grid reaches a national 90% clean electricity share by 2035—similar to the methods detailed in the original *2035 Report* (Phadke et al. 2020).

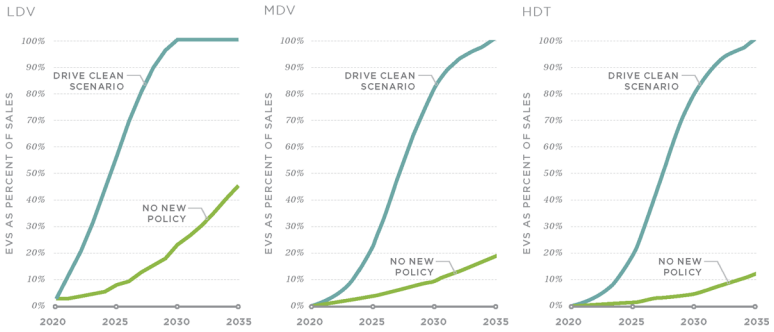


FIGURE 4.

EVs as percentages of sales by vehicle category in the No New Policy and DRIVE Clean scenarios.

SENSITIVITY ANALYSIS

We analyze three sensitivity scenarios to test the robustness of our results. A scenario with low gasoline/diesel prices and another scenario with high electricity prices demonstrate the competitiveness of EVs even when market factors are more favorable to ICE vehicles. To demonstrate the cost of delayed action, we also analyze a scenario that delays the 100% electric light-duty vehicle sales target by 5 years, to 2035.

METHODS

VEHICLE COSTS AND STOCKS

The starting point for our analysis is calculating the Total Cost of Ownership for EVs and ICE vehicles on a per-mile basis over the useful life of the vehicles.[5] We calculate TCO for six vehicle classes based on gross vehicle weight rating (GVWR) as defined by the Federal Highway Administration (DOE 2021). The TCO calculation includes the vehicle's upfront purchase price and sales tax along with average maintenance and fuel costs. The EV TCO also includes the cost of public charging equipment and the cost of battery replacements if the vehicle's useful life is longer than that of the batteries; we assume a battery life of 10 years.[6] For clarity, we present our findings in the more commonly used aggregate categories of LDVs, MDVs, and HDTs. Table 1 shows the six classes, their definition by GVWR, the fuel used (for ICE vehicles), their aggregate classification, and an example vehicle.

TABLE 1.

Vehicle classes and aggregated categories used in this study

CLASS	GVWR (LB)	AGGREGATED CATEGORY	ICE FUEL USED[7]	EXAMPLE VEHICLE
Class 1	0 – 6,000	LDV	100% gasoline	Sedan
Class 2a	6,001 – 8,500		100% gasoline	SUV
Class 2b–3	8,501 – 14,000	MDV	50% gasoline 50% diesel	Heavy-duty pickup
Class 4–5	14,001 – 19,500		100% diesel	Box truck Large walk-in truck City delivery truck
Class 6–7	19,501 – 33,000		100% diesel	School bus Refuse truck City transit bus
Class 7–8[8] tractors	26,001 – 33,001 +	HDT	100% diesel	Tractor-trailer

5 The TCO presented here is calculated over the entire useful vehicle life, as opposed to the shorter time spans that have been used elsewhere in the literature.

6 The TCO includes the cost of public charging infrastructure but not residential or workplace charging infrastructure.

7 We assume national average ethanol blending (10%) per the Annual Energy Outlook (EIA 2021).

8 Although class 6–7 and class 7–8 tractors overlap in GVWR, the latter specifically denotes vehicles designed for pulling trailers.

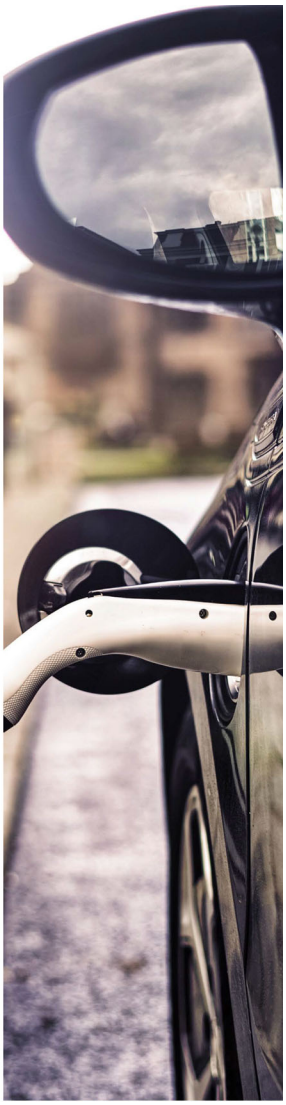
To model the dynamics of the nationwide vehicle fleet once EV sales targets are introduced, we use a custom vehicle stock turnover model. The stock model estimates ICE vehicles and EVs retired per year using a survival function modeled separately by vehicle class. We estimate the total number of vehicles sold per year using historical sales data from the Federal Reserve Bank of St. Louis (FRED 2021). Annual vehicle sales are allocated between ICE vehicles and EVs based on the EV sales target for that year. These nationwide estimates are downscaled to the state level based on scalar factors provided by the NREL Electrification Futures Study (Murphy et al. 2021). Combining the vehicle-level TCO and the vehicle populations from the stock model, we arrive at total fleet-level costs per year.

CHARGING INFRASTRUCTURE REQUIREMENTS

To facilitate analysis of light-duty vehicle charging infrastructure requirements and impacts to the power sector, we use NREL's Electric Vehicle Infrastructure Projection Tool (EVI-Pro) to estimate an annual (8,760-hour) EV charging load profile by state from 2020 through 2050. EVI-Pro provides a load profile for the following charging locations and power levels: residential Level 1 (L1), residential Level 2 (L2), workplace L1, workplace L2, public L2, and public direct-current fast-charging (DCFC). In line with the current state of the market, where advancements in charging technology have produced higher-capacity chargers at lower cost, we assume a phaseout of L1 chargers at work and home by 2025.

To estimate the number of public charging ports necessary to accommodate increasing EV penetrations, we first identify the maximum demand estimated by EVI-Pro in each year for residential, workplace, and public charging. The demand in each of these three categories is split nearly evenly among four charger types: 1.4-kW L1, 11-kW L2, 50-kW DCFC, and 100-kW DCFC. We then estimate the total number of chargepoints necessary to meet the peak charging demand, assuming a peak demand coincident utilization factor of 50%–90%, depending on charger category. Because the number of chargepoints per charging station varies widely depending on station design and location, we present our findings in terms of total chargepoints.

We assume that the HDT charging infrastructure will be installed at existing highway truck stops. We estimate the overall charging infrastructure requirement by modeling every existing U.S. highway truck stop and optimally siting 125-, 350-, and 1,000-kW chargepoints such that every long-haul freight mile a truck will travel is covered. The MDV charging infrastructure (50-, 125-, and



350-kW chargepoints) is assumed to be built at warehouses and parking lots such that all MDV miles traveled in any given day could be reliably charged. MDVs are also assumed to have access to the LDV and HDT charging infrastructure. The MDV and HDT traffic flows and miles traveled are taken from FHWA (2020).

ESTIMATING LOAD GROWTH

We estimate the hourly load shapes for LDV charging load using EVI-Pro. For MDVs and HDTs, we use hourly charging load shapes from NREL's Electrification Futures Study and scale them by the state-level vehicle stock and EV efficiencies from our scenarios.

To better understand the overall impact on the grid, we account for the increased trend toward electrification of buildings (residential and commercial) and industry that may occur in the United States between now and 2050. We use the high-electrification case (with moderate technology improvement) in NREL's Electrification Futures Study (Murphy 2021). In particular, we use state-level hourly load profiles by sector and end use, adjusting for distribution losses, as defined in the Electrification Futures Study.

POWER SECTOR MODELING

We perform power sector modeling using state-of-the-art models, based on the analysis conducted in the 2035 Report, including NREL's Regional Energy Deployment System (ReEDS) capacity-expansion model and Energy Exemplar's PLEXOS electricity production-cost model, in conjunction with publicly available generation and transmission datasets. Forecasts of renewable energy and battery cost reductions are based on NREL's Annual Technology Baseline 2019 (NREL 2019). We use these data and methods to analyze a national 90% clean electricity share by 2035, accounting for load growth from rapid transportation electrification as well as the electrification of industry and buildings.[9]

ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS

We rely on the peer-reviewed literature to estimate the value of environmental and public health impacts. For the transportation sector health impacts, we use national average mortality factors of vehicle miles traveled from Thakrar et al. (2020) to estimate total premature deaths due to vehicular criteria air pollutant emissions, specifically from primary and secondary

9 For details, see the 2035 Report (Phadke et al. 2020).

particulate matter ($PM_{2.5}$), in each year.[10] For the power sector health impacts, we use the same methodology used in the *2035 Report*. We estimate the change in yearly sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions (which contribute towards secondary $PM_{2.5}$ formation in the atmosphere) in each of the 134 grid regions based on the ReEDS output.[11] We then apply state-level mortality factors from Thind et al. (2019) to estimate total premature deaths due to SO_2 and NO_x emissions in each state.

We estimate the economic benefits of avoided CO_2 and $PM_{2.5}$ emissions using a methodology and values consistent with the *2035 Report*. We multiply the value of statistical life from Holland et al. (2020), $9.6 million (2020 real), with the avoided premature deaths due to primary and secondary $PM_{2.5}$ emissions reductions. The economic benefit of avoided CO_2 emissions is estimated using a social cost of carbon derived from Baker et al. (2019), Ricke et al. (2018), and Caldeira et al. (2016), which is $49.6/MT in 2020, increasing at 3% per year ($66.1/MT by 2030 and $76.6/MT by 2035). We multiply the social cost of carbon by net carbon dioxide (CO_2) emissions reductions from the transportation and power sectors.

EMPLOYMENT IMPACTS

Finally, we utilize Energy Innovation's Energy Policy Simulator (EPS) to evaluate the employment impacts of the DRIVE Clean scenario relative to the No New Policy scenario. EPS is an open-source system dynamics computer model developed to inform policymakers and regulators about which climate and energy policies will reduce greenhouse gas emissions most effectively and with the most beneficial financial and public health outcomes.[12] The EPS used the model outputs from the No New Policy and DRIVE Clean scenarios to calculate changes in jobs. The jobs module in the EPS is an input-output macroeconomic model which allocates changes in output resulting from policies to individual industries, sorted by International Standard Industrial Classification (ISIC) codes (United Nations 2008). Full documentation of the mechanics of EPS's jobs module is available online (Energy Innovation 2021).

10 $PM_{2.5}$ includes diesel particulate matter (DPM). DPM is a particularly harmful pollutant (also known as soot or black carbon) composed of carbon and organic compounds, many of which are known carcinogens. Exposure to DPM disproportionately impacts low-income communities and communities of color and is often concentrated near highways or ports (CARB 2021).

11 Owing to the limitations of ReEDs, our analysis does not include an estimate of primary $PM_{2.5}$ power sector emissions. This means that the result of our analysis is a conservative estimate of health impacts, particularly when going from a No New Policy scenario that includes more coal and gas generation, to a clean case that is dominated by renewables.

12 See generally, us.energypolicy.solutions.

DATA

Our key cost inputs are divided into two categories of assumptions: power-sector assumptions and transportation-sector assumptions. For the power sector, we rely on assumptions in the *2035 Report* 90% Clean Case (Phadke et al. 2020). For the transportation sector, key cost inputs include battery prices, upfront EV and ICE vehicle prices including sales tax, gasoline and diesel prices, electricity prices for charging, and vehicle maintenance costs. Upfront prices for all classes of EVs are determined by adding up the costs of batteries, electric drivetrains, vehicle assembly, and indirect costs, and then harmonizing with the sales prices of current or proposed EV models. Upfront EV prices decline through the early 2030s, in accordance with projected declines in battery prices, and then upfront prices stabilize through 2050. Because ICEs are an established technology, we assume upfront ICE vehicle prices remain stable throughout the study period. We assume a sales tax commensurate with recent International Council on Clean Transportation (ICCT) analyses of 8% for ICE vehicles and EVs (Yang 2016). The 2020 upfront vehicle prices for ICE MDVs and HDTs are in line with a 2019 California Air Resources Board (CARB) report (CARB 2019).

Electricity prices follow the EIA 2020 Annual Energy Outlook forecasts and assume national average residential, commercial, and industrial electricity prices for LDVs, MDVs, and HDTs, respectively (EIA 2021).[13] This assumption holds despite the

13 Rate designs for different vehicle types will vary from average rates, particularly if demand charges are relied on heavily in fast-charging applications. Although nuanced pricing is outside the scope of this analysis, the companion policy report from Energy Innovation addresses rate design and makes recommendations to avoid unduly high costs of charging that would conflict with this analysis.

fact that our assumed electricity mix is far cleaner than EIA's, because we find that a 90% clean electricity system results in approximately the same cost as today's system. The costs of gasoline and diesel similarly follow EIA projections. We source vehicle maintenance costs for medium- and heavy-duty electric and ICE vehicles from the CARB 2019 analysis (CARB 2019). Maintenance costs for LDVs are taken from a 2019 ICCT report; we assume cars correspond to class 1 vehicles and SUVs to class 2a vehicles (Lutsey 2019).

We triangulate vehicle operational characteristics, including average useful service life and vehicle-miles traveled (VMT), from several sources, including an analysis of California's EMission FACtors (EMFAC) 2017 data (CARB 2017), Environmental Protection Agency (EPA) rulemaking analysis (Federal Register 2002), and other industry reports. Finally, we use CARB's figures for fuel efficiency of ICE and electric MDVs and HDTs, and we use NREL's fuel efficiency projections for LDVs (Kontou 2018).

Table 2 summarizes key data inputs and sources. The appendix provides details.

TABLE 2.

Overview of key data inputs and sources

DATA	VALUE	SOURCE
Battery price	$133/kWh [2020] $62/kWh [2030] $55/kWh [2050]	BNEF (2020)
Diesel/gasoline price (national average)	$2.5/gal [diesel, 2020] $3.3/gal [diesel, 2030] $2.3/gal [gasoline, 2020] $2.8/gal [gasoline, 2030]	EIA Annual Energy Outlook (2020)
Electricity price	$0.13/kWh [2020] LDV $0.11/kWh [2020] MDV $0.08/kWh [2020] HDT	EIA Annual Energy Outlook (2020)
Vehicle Miles Traveled (VMT)	~15,000 mi/year for LDVs ~30,000 mi/year for MDVs ~61,000 mi/year for HDTs Decreasing over vehicle lifetime	Lawrence Berkeley National Laboratory (LBNL) analysis of 2017 EMFAC data (CARB 2017); EPA rulemaking research
Vehicle economic life	9–15 years	LBNL analysis of 2017 EMFAC data (CARB 2017); EPA rulemaking research
Maintenance costs	$0.06–0.09/mi for LDVs [ICE] $0.03–0.04/mi for LDVs [EV] $0.19/mi for HDTs [ICE] $0.14/mi for HDTs [EV]	CARB Staff Report: Advanced Clean Trucks Regulation dated 10/22/2019 (MDVs and HDTs) (CARB 2019); ICCT Update on Electric Vehicle Costs in the US through 2030 (LDVs) (Lutsey 2019)

DATA	VALUE	SOURCE
Upfront price	**Class 1 (LDV):** $40k (EV), $25k (ICE) [2020] $23.5k (EV), $25k (ICE) [2030] **Class 2a (LDV):** $52k (EV), $30k (ICE) [2020] $29k (EV), $30k (ICE) [2030] **Class 2b-3 (MDV):** $61k (EV), $50k (ICE) [2020] $45k (EV), $50k (ICE) [2030] **Class 4–5 (MDV):** $71k (EV), $55k (ICE) [2020] $55k (EV), $55k (ICE) [2030] **Class 6–7 (MDV):** $93k (EV), $85k (ICE) [2020] $77k (EV), $85k (ICE) [2030] **Class 7–8 tractor (HDT):** $210k (EV), $125k (ICE) [2020] $146k (EV), $125k (ICE) [2030]	CARB Staff Report: Advanced Clean Trucks Regulation dated 10/22/2019 for ICE vehicles (CARB 2019); LBNL bottom-up cost model for EVs
Tax	8% of purchase price	CARB Staff Report: Advanced Clean Trucks Regulation dated 10/22/2019 (CARB 2019)
Fuel economy	**EVs:** 3.5 mi/kWh for LDVs [2020] 4.1 mi/kWh for LDVs [2030] 0.5–1.8 mi/kWh for MDVs [2020] 0.5–1.9 mi/kWh for MDVs [2030] 0.4 mi/kWh for HDTs [2020] 0.4 mi/kWh for HDTs [2030] **ICE vehicles:** 29.7 mpg for LDVs [2020] 34.5 mpg for LDVs [2030] 6.6–7.5 mpg for MDVs [2020] 6.8–8.1 mpg for MDVs [2030] 6.1 mpg for HDTs [2020] 6.3 mpg for HDTs [2030]	CARB Staff Report: Advanced Clean Trucks Regulation dated 10/22/2019 (MDVs and HDTs), NREL (LDVs) (CARB 2019)
Cost of carbon	$49/MT [2020] $66/MT [2030]	Ricke et al. (2018); Caldeira et al (2016); Baker et al. (2019)
Non-GHG environmental cost of ICE vehicles	$0.025–0.022/mi for LDVs [2020–2030] $0.165–0.158/mi for MDVs/HDTs [2020–2030]	National average mortality factors from Thakrar et al. (2020) using damage costs from Holland et al. (2020)
EV range	250 mi for LDVs/MDVs 300 mi for HDTs	LDV based on most popular vehicles sales and average daily miles traveled; HDT based on average vehicle miles traveled using FHWA (2020) data

4
KEY FINDINGS

4.1 CONSUMER SAVINGS FROM EV OWNERSHIP START SOON AND GROW RAPIDLY

Historically, EV sales have been hindered by two consumer-cost disadvantages: the TCO and upfront prices of EVs have both been high in relation to ICE vehicles. Our results show, however, that proposed electric heavy-duty trucks already hold a TCO advantage today, and light-duty EVs will overtake ICE vehicles in TCO terms within 5 years. In addition, light-duty EVs will reach upfront price parity with their ICE counterparts in the mid to late 2020s (sooner for sedans than for SUVs), while electric trucks will approach upfront price parity with diesel trucks in the mid to late 2030s—eliminating the final, and most significant, consumer-cost barrier to EV ownership. Given this economic shift, accelerating EV deployment will yield considerable consumer-cost savings.

Figure 5 compares the TCO for EVs and ICE vehicles between 2020 and 2035. For light-duty vehicles, the $0.05/mi TCO disadvantage of EVs in 2020 changes to a $0.06/mi advantage by 2030. In absolute terms, in 2020 an electric passenger vehicle is $9,840 more expensive to own than the ICE equivalent. However, by 2030, an electric light-duty vehicle is nearly $12,800 less expensive. For heavy-duty trucks, an EV advantage of $0.05/mi in 2020 soars to $0.22/mi in 2030—magnified by the large number of miles traveled by this class of vehicles. In absolute terms, in 2020 this translates to a $42,800 TCO advantage of electric heavy-duty trucks, which increases to $200,000 in 2030. The TCO advantage of EVs continues to grow through 2050. For both LDVs and HDTs, EV economics improve primarily because of declining upfront vehicle prices, which are driven by declining battery prices (Figure 6). These falling upfront prices reduce the EV payback time, which is always shorter than the typical 15-year life of a vehicle (Figure 7). The TCO advantage grows more slowly between 2030 and 2050; in 2050, electric LDVs and HDTs have a $0.08/mi and $0.29/mi advantage, respectively. According to our analysis, light-duty electric vehicles are expected to achieve upfront price parity

with ICE vehicles when battery prices drop to $80–$100/kWh. We use the BNEF future battery price forecast and estimate that, between 2020 and 2030, battery prices will decline by 7.5% each year, such that batteries reach $100/kWh by 2025.

Our sensitivity analysis suggests that EVs remain cost-effective even when different assumptions affect their TCO adversely relative to ICE vehicles. With lower-than-expected gasoline and diesel prices, the lifetime mileage-averaged TCO of an electric vehicle still achieves parity with ICE vehicles in the early 2020s for all vehicle classes. With high electricity prices for EV charging, heavy-duty EVs still have a TCO advantage today, and light-duty EVs still reach TCO parity with ICE vehicles early in the 2020s. See the appendix for the sensitivity analysis results.

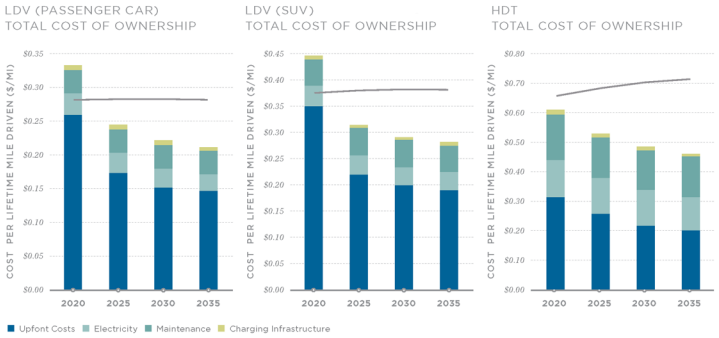


FIGURE 5.

TCO for EVs (bars) vs. ICE vehicles (lines), showing TCO parity achieved by 2023 for LDVs (left and center) and an existing TCO advantage for HDTs (right). Upfront costs include taxes. Maintenance costs of EVs include battery replacement cost.

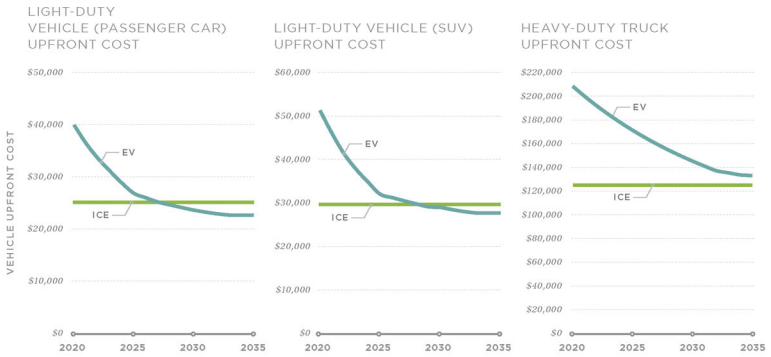


FIGURE 6.

Average upfront prices over time for ICE vehicles and EVs.[14]

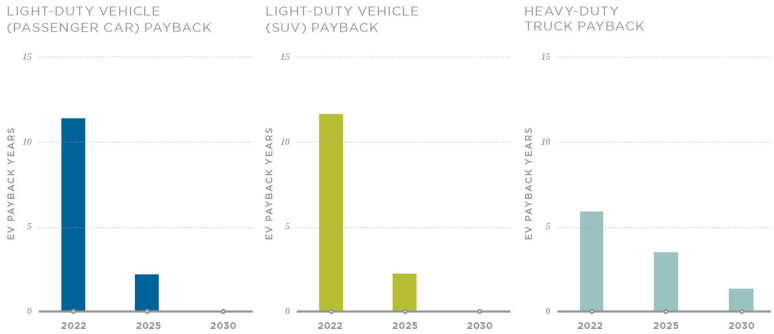


FIGURE 7.

Payback times (years required to recoup a higher upfront investment in an EV compared to an ICE vehicle) for Class 1 LDVs (left), Class 2a LDVs (center), and Class 8 HDTs (right). By 2025, the payback time for LDVs drops below 5 years, meaning that cumulative operational savings will fully offset the upfront EV price premium in less than 5 years, so every subsequent year results in direct consumer savings.

14 Passenger vehicle, SUV, and HDT denote vehicle classes 1, 2a, and 7–8 tractor, respectively.

The magnitude of national consumer savings from widespread EV deployment becomes clear when comparing the DRIVE Clean scenario with the No New Policy scenario. The DRIVE Clean scenario results in cumulative economic savings of approximately $2.7 trillion through 2050 compared to the No New Policy scenario. This translates to per household savings of approximately $1,000 per year on average over the next 30 years. The speed of the DRIVE Clean scenario is also critical to the savings realized. Many policy proposals suggest achieving 100% EV sales by 2035,[15] and this delayed goal might still be commensurate with a safe climate future (Orvis 2021). However, such a delay results in savings of only $2.2 trillion through 2050, $460 billion less than in the DRIVE Clean scenario, which electrifies all light-duty vehicles by 2030 (Figure 8). Those savings do not include the monetary value of human health and environmental benefits due to accelerated electrification, which make EV economics even more attractive (see Section 4.2).

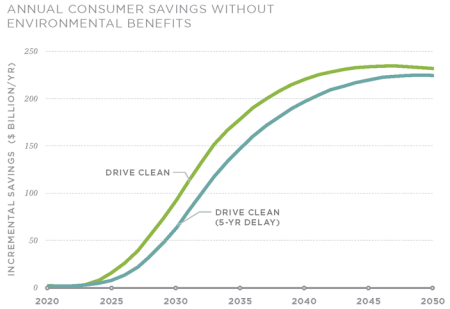


FIGURE 8.

Annual consumer savings in the DRIVE Clean scenario (cumulative savings of $2.7 trillion through 2050) and a delayed-electrification scenario (cumulative savings of $2.2 trillion through 2050).

4.2 ACCELERATING EV ADOPTION SAVES 150,000 LIVES, AVOIDS $1.3 TRILLION IN HEALTH AND ENVIRONMENTAL DAMAGES THROUGH 2050

Gasoline- and diesel-powered vehicles harm human health and the environment via emissions of pollutants such as NO_x and SO_2 as well as GHG emissions that contribute to climate change.

15 See the literature review in the appendix.

Accelerating EV adoption reduces both sources of damage dramatically. Compared with the No New Policy scenario, by 2050 the DRIVE Clean scenario reduces transportation sector emissions of NO_x by 96% and SO_2 by 99%, which dramatically reduces $PM_{2.5}$ exposure and avoids 150,000 premature deaths (Figure 9).[16] The health benefits would notably benefit low-income communities and communities of color, where vehicle pollution is worst. For example, African American, Latino, and low-income households in California are exposed to 43%, 39%, and 10% more $PM_{2.5}$ pollution, respectively, than white households (Reichmuth 2019). Broadly speaking, communities of color face higher risk from particulate pollution, and living or working near highways or heavy traffic is particularly risky (ALA 2020). Heavy-duty trucks contribute a disproportionate share of vehicle emissions. They constitute only 5% of U.S. on-road vehicles but are responsible for 36% of particulate emissions, suggesting that electrifying trucks can have an outsized influence on emissions and human exposure to pollutants (Kodjak 2015). When combined with the local air pollution reductions associated with a 90% clean electricity grid, the DRIVE Clean scenario avoids an additional 90,000 premature deaths through 2050.

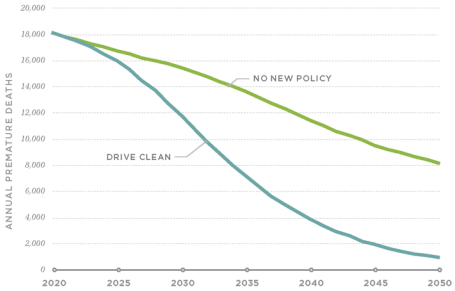


FIGURE 9.

Annual premature deaths in the No New Policy and DRIVE Clean scenarios, 2020–2050. The DRIVE Clean scenario avoids 150,000 premature deaths due to air pollution through 2050.

16 Primary $PM_{2.5}$ emissions reductions are not estimated by the model, resulting in a conservative estimate of reduced $PM_{2.5}$ exposure.

The DRIVE Clean scenario also slashes ground transportation sector CO_2 emissions by 60% in 2035—putting this sector on a path to meet its share of the global 1.5°C goal—and by 93% in 2050, relative to 2020 levels. Total transportation sector emissions are reduced by 48% in 2035 and by 75% in 2050, relative to 2020 levels (Figure 10). In total, the pollutant and CO_2 emissions reductions in the DRIVE Clean scenario equate to nearly $1.3 trillion in health and environmental savings through 2050, compared with the No New Policy scenario. These savings represent roughly $7,300 per car and $258,200 per HDT over the lifetime of each vehicle type. Combined with a 90% clean electricity grid by 2035, the aggressive electrification in the DRIVE Clean scenario would accelerate U.S. climate change mitigation efforts.

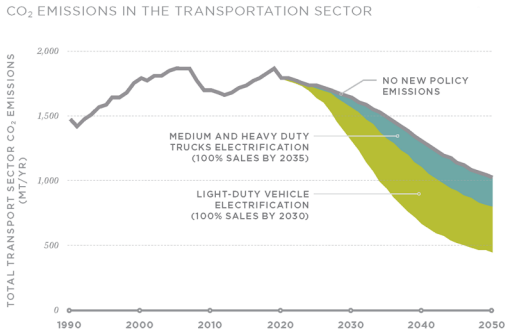


FIGURE 10.

Transportation sector CO_2 emissions in the DRIVE Clean and No New Policy scenarios through 2050.

DRIVE CLEAN SCENARIO ALIGNS WITH A 1.5°C PATHWAY

To avoid the worst impacts of climate change and commit the nation to a 1.5°C pathway, the United States must cut GHG emissions approximately in half by 2030 on its way to net-zero emissions by 2050. By 2030, the DRIVE Clean scenario reduces combined CO_2 emissions in the transportation and power sector by 58% relative to 2005 levels as vehicles electrify and the grid nears 90% clean electricity. At this point in 2030, economy-wide emissions reductions fall 35% relative to 2005 levels. If electrification in the buildings and industrial sectors is also pursued during this time, as modeled in our analysis, the result is an additional 10% reduction in economy-wide emissions, leading to 45% economy-wide emissions reductions by 2030 relative to 2005 levels. These emissions reductions are more aggressive than those in a recently published Energy Innovation analysis of a 1.5°C U.S. pathway, which assumes 100% zero-emission LDV sales by 2035 and 100% zero-emission HDT sales by 2045 (Orvis 2021).

4.3 ACCELERATING EV SALES GOALS SUPPORTS 2 MILLION JOBS IN 2035

Though economic recovery seems just within reach, major sectors of the U.S. economy remain devastated by the COVID-19 pandemic. Already with the American Rescue Plan Act of 2021, substantial resources have been allocated to help individuals, families, and businesses. Enacting policies that rapidly electrify America's transportation sector in line with the DRIVE Clean scenario present an opportunity to put more Americans back to work, and put more money back into consumers' pockets.

We model the employment impacts of the DRIVE Clean scenario using Energy Innovation's Energy Policy Simulator (EPS), an open-source system dynamics model developed to inform policymakers and regulators about which climate and energy policies will reduce greenhouse gas emissions most effectively and with the most beneficial financial and public health outcomes.[17] The EPS used the electricity grid and transportation model outputs to calculate changes in jobs between the DRIVE Clean and No New Policy scenarios, i.e. the net impact of the combined clean electricity standard and vehicle electrification policies.

17 See generally, energypolicy.solutions.

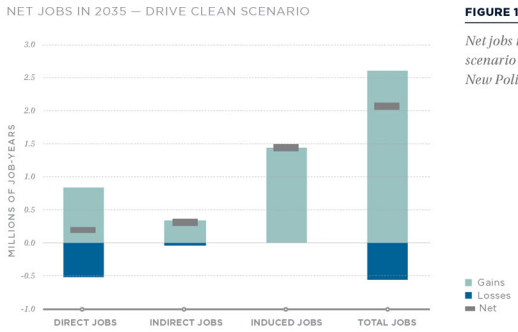


FIGURE 11.

Net jobs in 2035, DRIVE Clean scenario compared to the No New Policy scenario.

The DRIVE Clean scenario supports consistent job gains in 2020-2035, peaking at over 2 million jobs in 2035 compared to the No New Policy scenario (Figure 11). These employment gains are mostly induced jobs (1.4 million), spurred by $1 trillion in consumer savings that the electric vehicle transition will bring by 2035 based on the DRIVE Clean scenario. Assuming the same unionization rates by industry today, in 2035 union jobs increase by 276,000, while non-union jobs increase by 1.8 million. After 2035, net-job impacts of the DRIVE Clean scenario remain positive but start to decrease due to stable renewable build-out rates and decreasing power sector and vehicle operation and maintenance costs, though any job figures after 2035 remain highly uncertain.[18]

18 A job-year represents one full-time job held for one year.

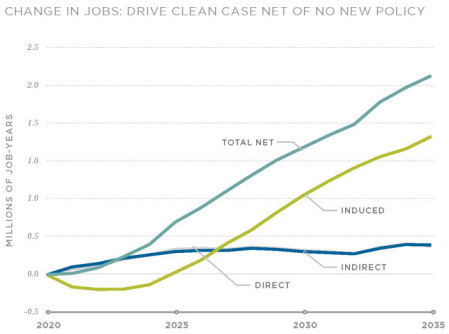


FIGURE 12.

Change in direct, indirect, and induced jobs in the DRIVE Clean scenario compared to the No New Policy scenario, 2020-2035.

The direct job impacts of the DRIVE Clean scenario are also positive overall. Altogether, gains in direct electricity and fuel sector jobs in 2035 (790,000) offset direct job losses in the auto sector (483,000). In 2035, job gains caused by the push to achieve a 90 percent clean electricity system with significant load growth are concentrated in construction (228,000), electrical equipment (105,000), and electricity delivery (197,000), and should be relatively evenly distributed among states as investment in clean electricity is ubiquitous. Direct impacts in auto manufacturing remain relatively unchanged.

The vehicle maintenance industry sees a loss of 470,000 direct jobs, though increased consumer spending induces some vehicle maintenance, retail, and wholesale job increases. The primary components of these jobs losses fall into two categories: vehicle repair and sales of vehicle components. Vehicle maintenance costs for light-duty electric vehicles is less than half that of comparable ICE models (Lutsey 2019). While consumers save substantially on electric vehicle ownership due to decreased repair costs, reduced vehicle maintenance has a negative impact on jobs in vehicle repairs. Likewise, reduced sales of vehicle components unique to ICE vehicles will tend to have negative impacts on jobs, while new opportunities will arise in some wholesale EV component industries.

The decline in vehicle repair jobs begins gradually, but increases after 2035, corresponding with the capital stock turnover of ICEs to EVs. Similar to the domestic manufacturing policies,

federal and state labor policies focused on retraining workers for the electrified economy should begin early, with a focus on adaptation and skills training for the clean transportation economy. Support for economic redevelopment and diversification beyond the clean energy industry can help more generally with an effective transition from an economy currently over-reliant on fossil fuels, to one powered by clean energy.

It is worth noting that the EPS does not predict a sharp decline in oil production jobs despite declines in domestic consumption, due to the fungibility of oil supply and prices in a global oil market. Though it is likely that the transition to EVs will continue and even accelerate globally, the impacts of worldwide transportation decarbonization is challenging to model at this juncture.

Finally, it is important to note that the EPS model used for this analysis does not account for the impact of "Made in America" domestic manufacturing policy impacts, which would likely alter the overall job picture for the U.S. under the DRIVE Clean scenario. EPS assumes that the domestic content of different industries remains constant at today's levels – at this moment, the U.S. lags behind other countries in the supply chain for EVs and energy storage components, but this could change with the right policy package. With an increased emphasis on domestic manufacturing, a few key industries could see domestic contributions in vehicles increase significantly, including chemical feedstocks to lithium-ion batteries, battery manufacturing, recycling, and assembly, EV manufacturing, and renewable energy manufacturing. Current labor dynamics and manufacturing capacity are discussed in Section 4.6 of this report, while policies to support domestic manufacturing in an electrified transportation future are detailed in the companion policy report from Energy Innovation, *Accelerating Clean, Electrified Transportation by 2035: Policy Priorities* (Baldwin et al. 2021).

4.4 EV PERFORMANCE AND AVAILABILITY CAN MEET THE NEEDS OF AMERICAN DRIVERS

In addition to TCO and upfront vehicle prices, vehicle performance and availability have historically hindered electric vehicle deployment. American drivers have become accustomed to the standards established by gasoline- and diesel-powered vehicles for vehicle range, fueling time, diversity of vehicle models, and—for commercial vehicles—weight. Fortunately, EVs

have been improving rapidly across all these dimensions, and our analysis suggests that they will not present significant barriers to accelerated electric vehicle deployment as envisioned in the DRIVE Clean scenario.

Light-duty ICE vehicles have an average range of about 350 miles on a full tank of gasoline, whereas the median range of today's EVs is over 250 miles and the industry maximum is over 400 miles, with a substantial upfront price premium for the longest-range vehicles (EERE 2021). Yet average electric vehicle range has been increasing, and the price of all models—including longer-range models—has been falling. As Figure 13 displays, nearly 75% of daily U.S. trips are less than 50 miles, and 96% are less than 125 miles, suggesting that a single EV charge is already sufficient to accomplish average driving tasks. In the near future, when average EV range increases, nearly 98% of all daily trips can be taken on a single charge (Figure 13). By 2025, a number of EV models will provide 350 miles on a single charge. However, upfront vehicle prices will need to continue declining to make these vehicles widely accessible to all American consumers.

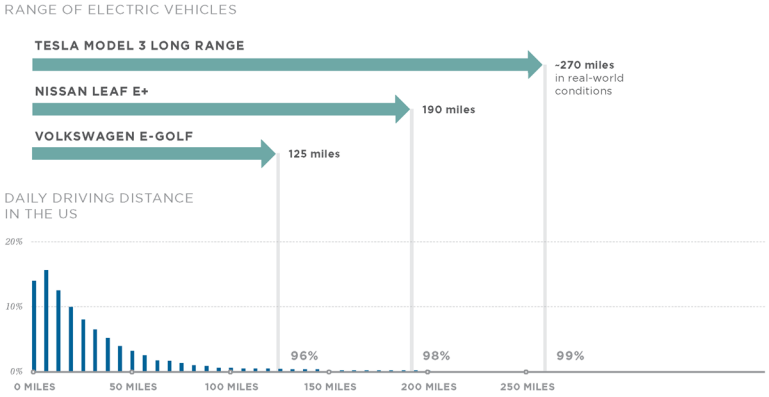


FIGURE 13.

Nearly 96% of U.S. passenger vehicle trips are shorter than 125 miles suggesting many EV models can meet average daily passenger vehicle needs (image recreated from ICCT 2020).

Refueling station availability and speed are closely related to range requirements. The expansion of station availability is covered in Section 4.5. One advantage of electric vehicles over ICE vehicles is their ability to charge at home, at workplaces, and even at parking structures or shopping areas, which mitigates range concerns to some extent. However, EV drivers will sometimes want the ability to charge as quickly as ICE vehicle

drivers can fuel—typically in about 5 minutes. DCFC comes closest to satisfying this need, with the potential to add over 100 miles of range in 5 minutes and almost 330 miles of range in 15 minutes (Figure 14). An increasing number of EV models offer fast-charging capabilities, which has the additional advantage of making electric vehicles more accessible to average Americans, because rapid, widely available charging can make lower-range, lower-cost EVs sufficient for a wide variety of driving needs (Gersdorf 2020). According to McKinsey, 26 range-extended EVs will be available by 2022 (Gersdorf 2020).

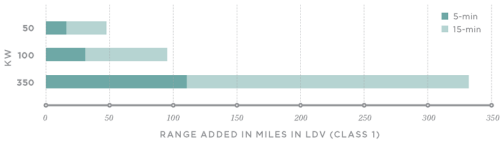


FIGURE 14.

EV range added during 5 or 15 minutes of charging for DCFC with various charging rates.

INCREASING EV DIVERSITY CAN MEET THE NEEDS OF AMERICAN DRIVERS

A diversity of LDV offerings is needed to satisfy the preferences of all American drivers. In 2020, automakers launched 105 new battery-electric passenger vehicles worldwide. That number will rise to at least 290 in 2022 (Gersdorf 2020). The United States should have at least 83 EV models available by 2022, with at least six models priced below $30,000 (MJB&A 2020). On average, automakers released approximately 40 new models each year during 2000–2019 in the United States, primarily ICE vehicles (BOA 2019). As the pace of vehicle electrification accelerates and ambition in the industry increases, more diverse vehicle models will become available, expanding the cost, performance, and size choices for EVs that can serve various consumer needs. Figure 15 shows the growth in light-duty EV models available globally between 2019 and 2022.

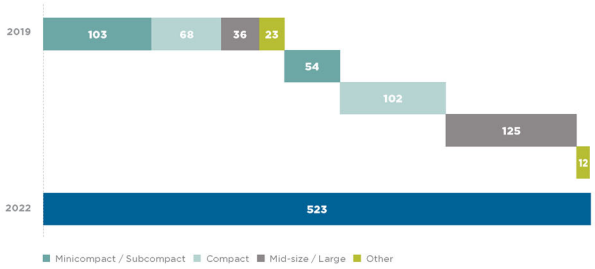


FIGURE 15.

Projected light-duty EV models available globally, 2022 (recreated from Gersdorf 2020).

The diversity of heavy-duty truck options is also expected to increase. Few commercial electric truck models exist on the market today, but Volvo, Tesla, Daimler, Mercedes-Benz, Peterbilt, BYD, and Kenworth will be producing Class 8 electric trucks in 2021 or 2022. New regulations, such as California's Advanced Clean Truck rule and the 14-state (plus Washington, D.C.) Memorandum of Understanding on MDV and HDT electrification, should continue to accelerate truck electrification (Governor 2020). Historically, the high costs and added weight of batteries have made HDT electrification challenging, but TCO for heavy-duty EVs is already cost-competitive, the weight differential is narrowing, and upfront prices will approach parity with ICE trucks in the late-2030s (see Section 4.1 and the appendix).

Range and tradeoffs among battery density, weight, and payload capacity reductions are a challenge for electric heavy-duty trucks. However, the payload capacity reduction for forthcoming electric HDT models with a 375-mile range is around 5% or less, and only a small fraction of trucks use the maximum payload limit. In addition, the electric drivetrain will be significantly lighter than a diesel drivetrain, which helps offset the weight of a battery pack relative to an engine. Improved aerodynamics and lightweighting technology can enable additional range (Phadke et al. 2021). Furthermore, most trucks today are limited by volumetric capacity constraints, not payload weight. As such, most trucks would consider a 5% payload weight reduction to be of little consequence while enabling manufacturers to include larger batteries to extend truck range (such as a forthcoming 600-mile range battery claim from Tesla). To enable rapid charging of trucks, DCFC even more powerful than the types used for LDVs would be required. 1 MW charger could add significant range (~250 miles) to a 375-mile range truck in 30 minutes, and faster charging speeds are possible, such as forthcoming Megawatt Charging Systems (NREL 2020). The speed of charging and commensurate added range are important for a number of vehicle classes. Fortunately, many MDV and HDT applications require frequent stops or short trips and can be covered with the range available in new electric MDVs and HDTs. For example, many delivery vans, buses, or regional haul trucks will drive less than 100 miles before stopping, well within the range of forthcoming electric MDV/HDT battery range (Figure 16). See Section 4.5 for information on national charging requirements.

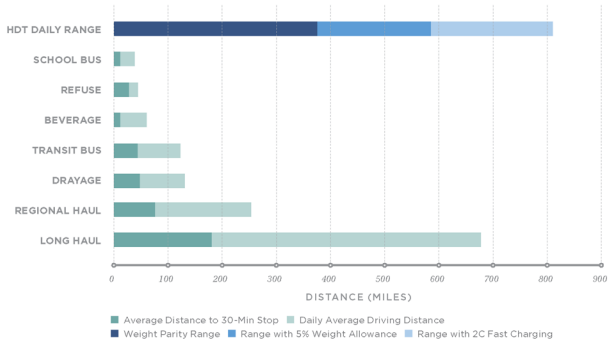


FIGURE 16.

Electric trucks can add sufficient range without compromising payload weight across many MDV and HDT classes (recreated from Smith 2019).

4.5 REQUIRED CHARGING INFRASTRUCTURE CAN BE BUILT COST-EFFECTIVELY TO SERVE THE ENVISIONED EV FLEET

To enable the DRIVE Clean scenario, U.S. electric vehicle charging infrastructure must provide drivers with at least as much convenience as provided by existing gasoline and diesel fueling stations. A 2019 poll suggests the largest roadblock to increased EV sales is the unavailability of or distance to charging stations (Toth/Morning Consult 2019). As fast charging and longer battery ranges become more ubiquitous, this dynamic may change. EVs with 250–300 miles of range are rapidly becoming cost-competitive and more widely available to many American consumers. Many automakers will soon offer fast-charging capabilities that add 50–100 miles of range in 5–10 minutes. Widespread availability of home-charging infrastructure will further alleviate range concerns. The pace of the required DRIVE Clean infrastructure scaleup is challenging but achievable, and the costs are modest compared with the benefits of widespread electric vehicle deployment.

LIGHT-DUTY VEHICLE CHARGING

The DRIVE Clean scenario dramatically accelerates U.S. deployment of LDV charging infrastructure. In 2020, the United States installed about 34,000 new public chargepoints, bringing total U.S. public chargepoints to approximately 100,000 (AFDC 2021a and EVAdoption 2021). This number must grow to 8.1 million public chargepoints over the next 30 years, including 860,000 50-kW DCFC chargepoints, 330,000 100-kW DCFC chargepoints, and 6.9 million L2 chargepoints—a combined average of about 270,000 public LDV chargepoints (L2 and DCFC) installed annually (Table 3). Between 2020 and 2050, approximately 3.5 million at-home chargepoints must be built each year. As of 2019, approximately 1.5 million at-home chargepoints were installed in the United States (IEA 2020).

TABLE 3.

Total LDV chargepoint installations in the DRIVE Clean scenario

	TOTAL INSTALLATIONS		AVERAGE ANNUAL INSTALLATIONS	
	2020–2035	2036–2050	2020–2035	2036–2050
Home	72 million	33 million	4.8 million	2.3 million
Work	2.5 million	760,000	170,000	51,000
LDV Public L2	5.2 million	1.7 million	350,000	110,000
LDV Public DCFC	900,000	290,000	60,000	19,000

Experience in other areas suggests this rapid expansion is aggressive but achievable. China installed about 300,000 public chargepoints in 2020 (McLane 2021), and Europe installed around 60,000 (EAFO 2020). Globally, the number of public chargepoints grew about 60% in 2019 from the year prior. About 6.5 million private chargers were in use worldwide in 2019 (IEA 2020).

We assume 75% of light-duty vehicles have access to dedicated home charging by 2050, while the remaining 25% depend solely on public charging infrastructure. For vehicles with access to home charging, we still assume 20% of charging needs are served by public charging infrastructure. Providing equitable access to public charging infrastructure is crucial. Our analysis gives siting preference to zip codes with low availability of dedicated home charging (implying higher concentrations of multi-dwelling and rented units), lower average income levels, and higher populations of vehicles (Figure 17).

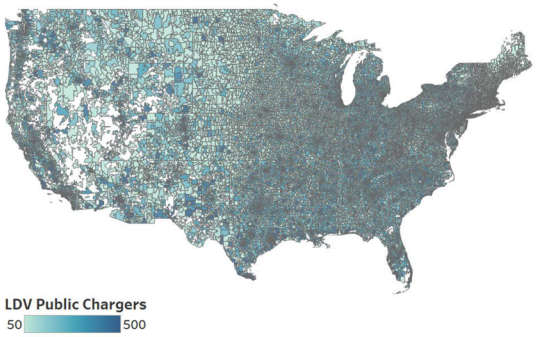


FIGURE 17.

LDV public charging infrastructure per zip code by 2050, prioritized by low availability of dedicated home charging (implying higher concentrations of multi-dwelling and rented units), low-income areas, and higher vehicle populations in the region.

MEDIUM-DUTY VEHICLE AND HEAVY-DUTY TRUCK CHARGING

Fewer chargepoints are needed for MDV and HDT charging under the DRIVE Clean scenario, totaling about 1.05 million between 2020 and 2050 – about 900,000 for HDTs and 150,000 for MDVs (Table 4). This equates to a combined average of 35,000 chargepoints each year during 2020–2050, including an average of 19,000 chargepoints per year in the 2020s and 53,000 chargepoints per year in the 2030s.

TABLE 4.

Total MDV and HDT chargepoint installations in the DRIVE Clean scenario

	TOTAL INSTALLATIONS		AVERAGE ANNUAL INSTALLATIONS	
	2020–2035	2035–2050	2020–2035	2035–2050
MDV	85,000	82,000	5,500	5,500
HDT	300,000	590,000	20,000	40,000

The combination of 125-, 350-, and 1,000-kW HDT chargepoints will be spread across about 2,700 truck stops. We model every existing U.S. highway truck stop and site charging stations such that every long-haul freight mile a truck will travel is covered with a chargepoint (Figure 18). Siting HDT charging along existing rights-of-way simplifies installation. However, new fast-charging stations will require upgraded power infrastructure, which could slow deployment. The accompanying policy report discusses strategies to enable truck charging infrastructure.

Another challenge for electrifying trucks is the availability of fast charging at intervals appropriate to an electric HDT's range. Currently, the average distance to a 30-minute truck stop is approximately 190 miles (Figure 16).[19] However, if a national high-speed charging network is built along existing trucking routes, with 500-kW or better fast-chargers capable of adding sufficient HDT range in 30 minutes, these range concerns will be allayed for most long-haul trucking use cases.

A combination of 50-, 125-, and 300-kW medium-duty vehicle chargepoints will be spread across the country, primarily sited at MDV parking depots and warehouses so vehicles can charge overnight or when they park between shifts (Figure 19).

19 Federal law requires a 30-minute break for long-haul truck drivers after 8 hours of continuous travel.

FIGURE 18.

Optimal siting of HDT charging infrastructure, 2050. Every long-haul freight mile along major highways is electrified.

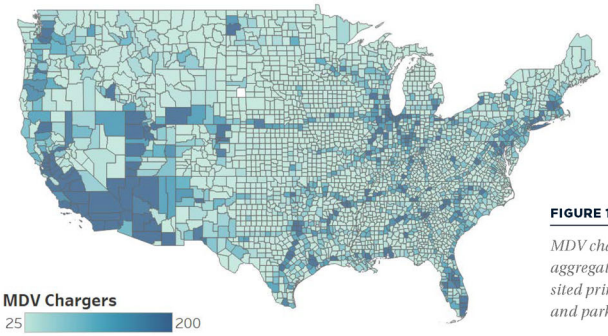


FIGURE 19.

MDV charging infrastructure aggregated at the county level, sited primarily at warehouses and parking lots, 2050.

CHARGING INFRASTRUCTURE INVESTMENT

The cost of building the DRIVE Clean charging infrastructure is modest compared to the scenario's benefits. For light-duty vehicles, of the $11 billion required annually through 2035, $6.8 billion is for home charging, $510 million for workplace charging, $1.1 billion for L2 public charging, and $2.6 billion for DCFC (50 and 100 kW). Annual heavy-duty truck and medium-duty vehicle public charging infrastructure investments through 2035 are

$3.6 billion and $390 million, respectively. Beyond 2035, annual charging infrastructure investments for HDTs and MDVs increases to $6.3 billion and $520 million, respectively, while public L2 and DCFC investments for LDVs falls to $460 million and $1.1 billion, respectively. The cumulative investment in public charging infrastructure makes up a small portion of EV TCO in the DRIVE Clean scenario (see Section 4.1). As another point of comparison, U.S. utilities invest about $30 billion annually in new electricity distribution system upgrades (Figure 20) (EEI 2021). Still, the United States must commit to accelerating project-development timelines—already a major hurdle in charging infrastructure deployment—to reach DRIVE Clean levels on time. The accompanying policy report from Energy Innovation provides recommendations to facilitate equitable charging infrastructure deployment (Baldwin et al. 2021).

While the power sector analysis considers the impact of vehicle electrification on new generation and transmission investments (Section 4.7), it does not consider impacts to the distribution system. The distribution grid will require upgrades to support new electric loads from vehicle charging. A supporting analysis from E3 evaluates the distribution system investments that would be required to support electrification, drawing from both top-down (marginal cost study based analysis) and bottom-up (based on distribution resource planning assessments) approaches. E3 presents a range of estimates of distribution system investments over the next 30 years based on annual EV sales and associated charging infrastructure requirements of the DRIVE Clean scenario. The mid-case estimate suggests a cumulative $116 billion of distribution system investments over the next 30 years, or approximately $3.7 billion per year. Low and high estimates range from $900 million to $5 billion of distribution system investments per year. The cost of public charging, including the estimated distribution upgrade costs, will not increase rates, however, as the increased electricity sales helps increase throughput for utilities in order to cover the additional expenses. In fact, the analysis shows that even in the high estimate of distribution cost upgrades, distribution rates ($/kWh) would actually fall by 2% through 2035. The full analysis of distribution system investments is detailed in the appendix.

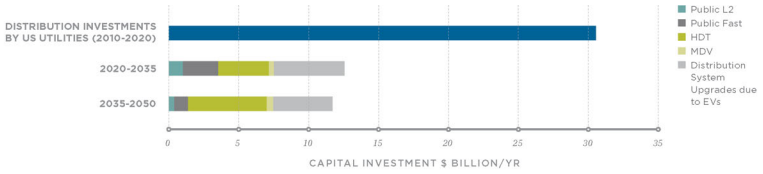


FIGURE 20.

Average annual capital investment in public L2 charging, public DCFC, and public MDV/HDT DCFC necessary to support the DRIVE Clean scenario, 2020–2050, compared with average annual capital investment in public distribution system upgrades, 2010–2020. To illustrate public investment, we include only public charging infrastructure needs in this chart, not private home or workplace charging.

4.6 GLOBAL AND DOMESTIC SUPPLY CHAINS CAN SATISFY ACCELERATED EV AND BATTERY PRODUCTION, LED BY U.S. COMPANIES

To achieve the DRIVE Clean scenario—with simultaneous EV expansion worldwide—significant scaleup of EV supply chains is required. However, we find no insurmountable barriers to an expansion of the requisite scale and speed. In fact, accelerated U.S. EV deployment will present opportunities for U.S. leadership in EV manufacturing in an increasingly competitive global context. Here we show how vehicle manufacturing, battery manufacturing, and battery raw material sourcing and recycling can evolve to support the DRIVE Clean vision.

VEHICLE MANUFACTURING

With strong policy support, future domestic and global EV manufacturing capacity should be sufficient to meet the DRIVE Clean goals. In 2019, U.S. light-duty vehicle sales included 326,000 electric vehicles (AFDC 2021b). The DRIVE Clean scenario would require annual U.S. light-duty EV sales to grow from 326,000 to 14.6 million between 2019 and 2030. Assuming the United States continues to manufacture 70% of light-duty EVs sold domestically, in 2030 it would need to manufacture at least 10.2 million light-duty EVs, plus any EVs that are exported for sale.

EV manufacturing capacity in the United States is already expanding rapidly. Domestic manufacturers have announced plans to spend at least $30 billion in EV manufacturing and development (MJB&A 2020). Conversion of existing vehicle lines to EV production can occur more quickly than greenfield manufacturing development. For example, Tesla purchased a closed vehicle manufacturing plant in Fremont, California in 2010 and produced its first vehicle just 2 years later. In 2020, it produced 500,000 EVs with 10,000 employees (NS Energy 2020). The Lordstown Motor Corporation recently purchased a closed auto factory in Ohio and will produce its first electric

commercial pickup truck this year, with production of 50,000 vehicles projected for 2022; the site can be scaled to produce 600,000 vehicles per year (Raja 2021).

Other domestic car manufacturers have also announced aggressive plans to expand EV production. General Motors plans to spend $27 billion to manufacture 25 electric models by 2025, and it expects to phase out ICE vehicles entirely by 2035 (Colias 2021).[20] Ford announced in February 2021 that all its new cars sold in Europe, some of which will be manufactured in the U.S., will be electric or plug-in hybrid by 2026 and fully electric 4 years later, and that two-thirds of its commercial vehicles will also be all-electric or plug-in hybrid by 2030 (Mufson 2021). American carmaker Lucid will release an electric luxury sedan with a 500-mile range in late 2021, while Rivian is already producing electric vans in Illinois so it can deliver 100,000 vehicles to Amazon.

Although MDV and HDT manufacturing is at a smaller scale than LDV manufacturing, it presents unique domestic opportunities, and domestic truck manufacturing is ramping up quickly. Most major U.S. MDV and HDT manufacturers have committed to 100% fossil-free product sales or are subsidiaries or parents of companies that have done so (ACEA 2020).[21] More than 125 zero-emission MDVs and HDTs are in production, development, or demonstration in the United States (Sharpe 2020).

The characteristics of medium- and heavy-duty EVs make them well suited to domestic manufacturing. Their economics are currently better than the economics of light-duty EVs owing to higher utilization, access to low-cost commercial or wholesale electricity rates, and their tendency to use central or highway artery charging infrastructure. Electric MDVs and HDTs are less likely to be imported owing to their size and weight. Despite these trends, however, strong policy is needed to accelerate MDV and HDT manufacturing and achieve the DRIVE Clean goals.

BATTERY MANUFACTURING

Strong policies could also enable the United States to ramp up battery manufacturing sufficiently to achieve the DRIVE Clean goals. Today, the United States produces about 60 GWh/year,

20 General Motors already has extensive experience with EV manufacturing owing to its market share of EVs in China. Its Wuling brand, Hongguang Mini, became the top-selling EV in China in late 2020. Its Chevrolet Bolt sales in the United States doubled in the fourth quarter of 2020 from a year earlier.

21 Companies committing to 100% zero-emission truck sales by 2040 include (subsidiaries in parentheses): Ford Trucks, Daimler (Freightliner, Western Star, Mercedes-Benz, Detroit Diesel), DAF (Paccar, Peterbilt, Kenworth), and Volvo (Mack Trucks). Other companies that manufacture trucks in the United States that have committed to all electric sales include Tesla, BYD, Chanje, Nikola, Rivian, Workhorse, XOS, Arrival, GGT Electric, and Lion Electric (Quebec). Companies producing electric drivetrains in the United States for trucks include Cummins and Meritor.

or 13%, of global lithium-ion battery capacity (Gul 2020). That capacity is currently projected to reach approximately 160 GWh by 2025 (Albanese 2020). The DRIVE Clean scenario requires approximately 600 GWh of total battery manufacturing capacity in 2025 and 1,200 GWh of manufacturing capacity by 2035. These requirements do not need to be met domestically, but the United States has strong economic and security interests in growing its own manufacturing capacity. With policy support, battery manufacturing can expand rapidly. China tripled its battery manufacturing output in just 1 year from 2014 to 2015 (Green Car Congress 2016).[22] For comparison, global demand for lithium-ion vehicle batteries is about 300 GWh today, and global battery manufacturing capacity is projected to exceed 2,000 GWh by 2028, with significant expansions in the European Union (EU) and China (Figure 21) (Benchmark 2019).

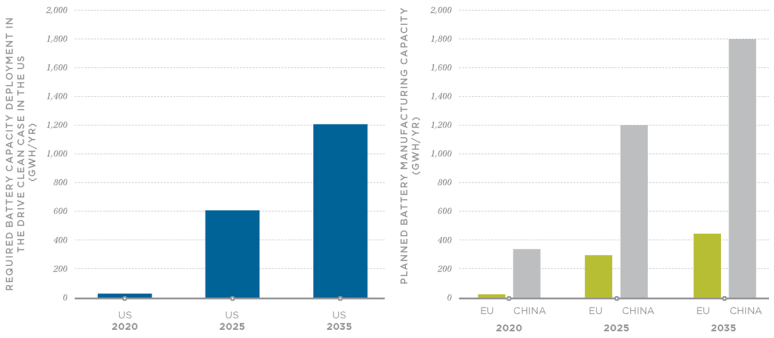


FIGURE 21.

Total required annual U.S. battery capacity under the DRIVE Clean scenario (left) and planned battery manufacturing capacity in the EU and China (right), 2020–2035.

The DRIVE Clean scenario presents an opportunity to expand U.S. battery manufacturing substantially, which would create jobs and increase the U.S. share of the global market. Economics favor manufacturing near sales markets, because batteries are heavy and expensive to transport. As EV and grid-scale battery demand increases, the economics of domestic battery manufacturing improve owing to scale. Lithium-ion battery costs already have declined rapidly. Growing investment in the

22 It takes about 2–4 years from announcement to production for a large-scale lithium-ion battery factory in the United States. Construction of the Tesla Gigafactory in Nevada took 2 years.

domestic lithium-ion supply chain will further reduce costs, particularly as the United States expands its technical prowess in solid-state lithium-ion technology. Just as China built its global lead in battery production in 10 years, strong U.S. policies can ensure increased battery production to support the DRIVE Clean goals (Jin 2021b).

GLOBAL BATTERY RAW MATERIALS AND RECYCLING

Enabling high levels of electric vehicle manufacturing requires a reliable supply of raw materials for advanced batteries. Production of materials such as lithium, cobalt, and graphite must expand dramatically to meet this demand. Most battery raw material production is currently located outside of the United States, often in potentially unstable nations. Uncertainties surrounding the raw material supply chain include the following:

- The effect of changing lithium-ion battery design and chemistry on demand for rare earth metals
- The potential for interruptions to world trade in raw materials due to conflicts or the unacceptable labor conditions under which materials are obtained
- The effect of global competition for raw materials on supply and costs
- Potential reductions in raw material import requirements due to investment in rare earth metals recycling

Most analysts, however, expect battery raw material supplies—with the possible exception of lithium—will not constrain battery production during the next 10 years, and efforts are underway to address lithium supplies and demand (McKerracher 2021; Slowik 2020). Governments worldwide are planning numerous efforts to address longer-term supply risks for other minerals and elements (Fehrenbacher 2021).

Cost-effective battery recycling is a promising way to secure raw materials, reduce waste, and create high-quality jobs. One study suggests that 15 jobs are created to recycle every 1,000 metric tons of end-of-life lithium-ion batteries (Akram 2020). Multiple systems and processes already exist to recover rare earth metals from used batteries. Battery recycling will be especially important for the United States as it achieves high-volume EV manufacturing in the 2020s and 2030s. The United States could meet about 30%–40% of anticipated demand for lithium, nickel, manganese, cobalt, and graphite in passenger EVs with recycled battery materials by 2035 (Reichmuth 2019).

To date, China is the only country with a dedicated vehicle

battery recycling policy (Reichmuth 2019). The European Commission has proposed requiring collection of used batteries and implementing standards for recycled content in new batteries. In 2020, the United States established a consortium of agencies to promote a domestic battery industry, citing the role the industry plays in consumer electronics and national defense and suggested using the Defense Production Act to speed development of mines for rare earth elements. Congress included provisions to secure domestic and allied sources of strategic minerals and metals, including lithium, in the National Defense Authorization Act for fiscal year 2021 (Lasley 2020).

In early 2021, President Biden ordered a 100-day review of U.S. supply chain vulnerabilities for critical items, including EV batteries and specialized minerals (Lynch 2021). One outcome of this review could be a decision (following the examples of the EU and China) to establish recycling incentives or regulations, require battery products to be standardized for easy disassembly, develop second-life battery uses, and establish tracing systems for battery components.[23] These are some of the reasons to expect that U.S. battery production can supply a substantial portion of the batteries and raw materials needed to meet the DRIVE Clean goals.

4.7 ELECTRIC GRID IMPACTS OF THE ENVISIONED EV FLEET ARE MANAGEABLE

The DRIVE Clean scenario represents a significant change in the composition of U.S. electricity supply and demand, with clean generation making up 90% of supply, and demand increasing 25%. However, the aggressive expansion of renewable energy generation is achievable, and the resulting wholesale electricity cost is lower than today's costs. Most importantly, the high-renewables, high-electrification vision of the DRIVE Clean scenario results in a dependable U.S. electricity grid.

The DRIVE Clean scenario requires a substantial increase in U.S. renewable energy installations due to the accelerated electrification of the transportation, industry, and residential and commercial buildings sectors. The combined demand growth requires electricity generation to increase approximately 2% per year, consistent with the 2.6% average historical growth in the electric sector during 1975–2005, when emissions in

23 There are also policy options for battery raw material at the state level. A bill in the California legislature would condition eligibility for state fleet procurement programs on vehicles with batteries having a minimum content of lithium mined in California.

the industry peaked. In the *2035 Report*, we showed that the electric grid must add 70 GW of new wind and solar resources and 10 GW of new battery storage each year to achieve 90% clean electricity generation by 2035, a rate comparable to the highest level of annual generating capacity deployment in recent history (Phadke et al. 2020). The DRIVE Clean scenario increases that rate by about 50%, installing on average 105 GW of wind and solar annually (Figure 22). For reference, the United States installed around 31 GW of new utility-scale renewable capacity in 2020, despite the pandemic (SEIA 2021; ACP 2021). The DRIVE Clean scenario also requires about 30 GW (180 GWh) of battery storage (2- to 10-hour batteries) each year. This ambitious target will require strong policy support, but it is not unprecedented internationally. China installed 120 GW of wind and solar capacity in 2020 (Murtaugh 2021). Figure 23 details U.S. electric capacity additions under the DRIVE Clean scenario in the 2021–2035 period.

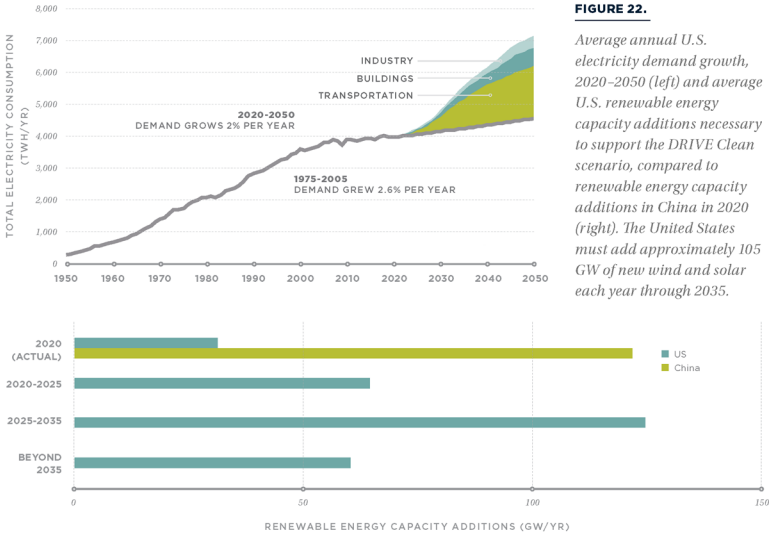


FIGURE 22.

Average annual U.S. electricity demand growth, 2020–2050 (left) and average U.S. renewable energy capacity additions necessary to support the DRIVE Clean scenario, compared to renewable energy capacity additions in China in 2020 (right). The United States must add approximately 105 GW of new wind and solar each year through 2035.

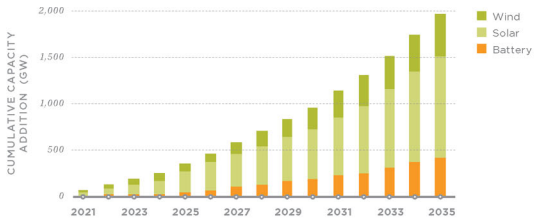


FIGURE 23.

U.S. electricity capacity additions in the DRIVE Clean scenario, 2021–2035.

The average electricity generation cost in 2035 in the DRIVE Clean scenario is slightly lower than 2020 electricity costs owing to the steep renewable energy cost reductions and higher system utilization enabled by increased electrification. The benefit derives from the complementary load profiles of different types of EV charging and electric loads in the buildings sectors—electricity use is higher in the DRIVE Clean scenario, but it is more evenly distributed across seasons. In 2035, the additional electricity demand is dominated by EV charging (Figure 24). Public chargers are primarily used during the day and home chargers in the evening, helping to smooth load across all hours of the day. Small load increases from building electrification occur mostly in winter due to space heating. The higher winter load results in more efficient renewable energy use, because net peak load occurs in summer, with significant renewable energy curtailment in winter and spring. The higher winter load reduces curtailment in those months, which also reduces the need for battery capacity.

The system benefits increase as electrification increases. In 2050, the total additional load is much higher—with more significant contributions from buildings and industry—but the additional load profiles are still relatively flat, and the difference between winter and summer peak loads is smaller than it is in 2035 (Figures 24 and 25). These characteristics further reduce renewable energy curtailment and average generation costs. Our study does not assume availability of flexible loads such as managed EV charging or demand response from building loads, but flexibility would further increase system efficiency and reduce costs under the DRIVE Clean scenario. Demand-side flexibility in the form of increased demand response or flexible chargers and water heaters, for example, would also significantly reduce additional transmission or distribution investments needed to support the load growth.

FIGURE 24.

Average hourly load profile in the DRIVE Clean scenario during January (left) and July (right), 2035. The baseline load (with no additional electrification) is shown by the dark blue line, while the areas above show the additional load due to electrification of each end-use.

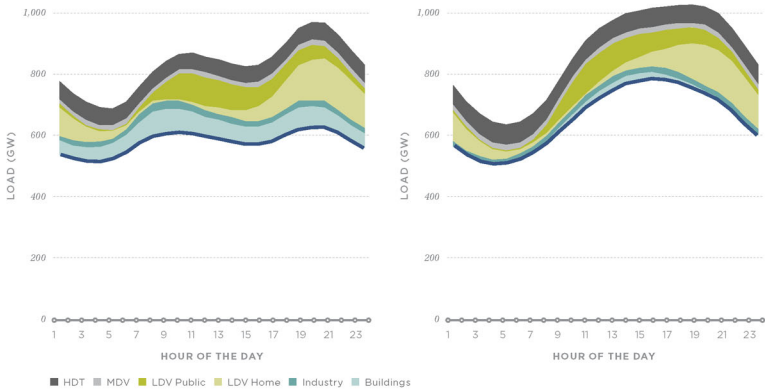


FIGURE 25.

Average hourly load profile in the DRIVE Clean scenario during January (left) and July (right), 2050. The baseline load (with no additional electrification) is shown by the dark blue line, while the areas above show the additional load due to electrification of each end-use.

Even with additional electric loads, the 90% clean grid is dependable without coal plants or new natural gas plants through 2035. To model operation of a low-carbon power system with additional electrification load, we analyze U.S. hourly dispatch at the powerplant level using PLEXOS. We incorporate 7 years of weather data (2007–2013) to evaluate the impact of extreme weather events on renewable generation and load. To ensure grid dependability and estimate the generation capacity required to meet system demand in every hour, even during periods of low renewable energy generation and/or high demand, we simulate hourly operation of the U.S. power system for more than 60,000 hours (each hour across 7 weather years). For each hour, we confirm how electricity demand is met in each of 134 regional zones (parts of the U.S. power system represented in the model) while abiding by technical constraints (such as ramp rates and minimum generation) and operational requirements (such as provision of ancillary services like spinning, regulation, and load-following services) for more than 15,000 individual generators and 310 transmission lines.

To highlight the dependability of a 90% clean electricity grid with additional electrification load under the DRIVE Clean scenario, and to estimate natural gas capacity requirements, we identify the period during the 7 weather years when maximum natural gas generation capacity is needed to compensate for the largest gap between clean electricity generation (including battery generation) and load. The maximum natural gas capacity required is about 311 GW on February 2nd of the 2010 weather year (Figure 26). At 7 AM Eastern Time on that day, solar generation is zero, while wind generation is 85% below installed wind capacity, resulting in approximately 81 GW of wind and solar production (about 82% below the 7 year renewable generation hourly average). The additional electricity demand due to home charging (4.5 GW) and public charging (50 GW) of electric vehicles is significant, while electrification of buildings (44 GW) and industry (12 GW) contributes an additional 56 GW. The total system demand of about 627 GW is met by a combination of other clean resources, such as 118 GW of hydropower and nuclear, approximately 311 GW of existing natural gas, and 115 GW of battery discharge.

HOURLY DISPATCH DURING THE MAX GAS GENERATION WEEK

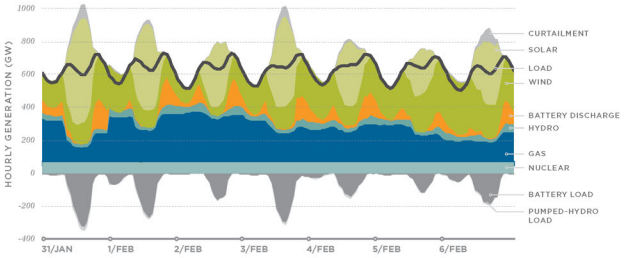


FIGURE 26.

Hourly dispatch during the highest gas generation week.

Figure 27 shows how the electricity load would be met every day of the year in 2035, while Figure 28 shows hourly national grid dispatch in each month averaged over the 7 weather years. In all months, wind provides a large share of the evening and nighttime generation, and solar provides a large share of daytime generation. Battery storage is primarily dispatched in the evening when solar generation drops and load remains relatively high. For all weather years, the natural gas capacity requirement is highest in July/August due to summer peak load and in January/February due to increased electrified heating load and a drop in solar generation (Figures 27 and 28).

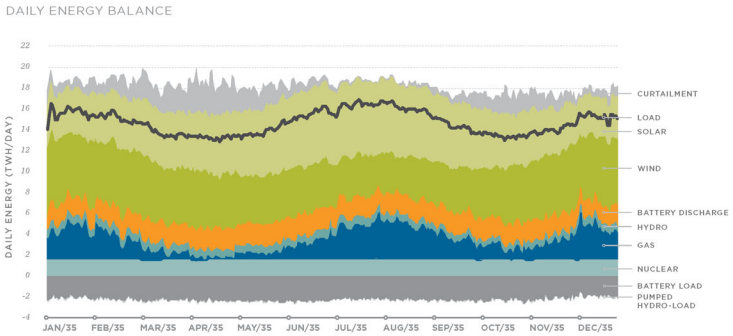


FIGURE 27.

Daily U.S. power system dispatch, averaged over 7 weather years, under the DRIVE Clean scenario in 2035.

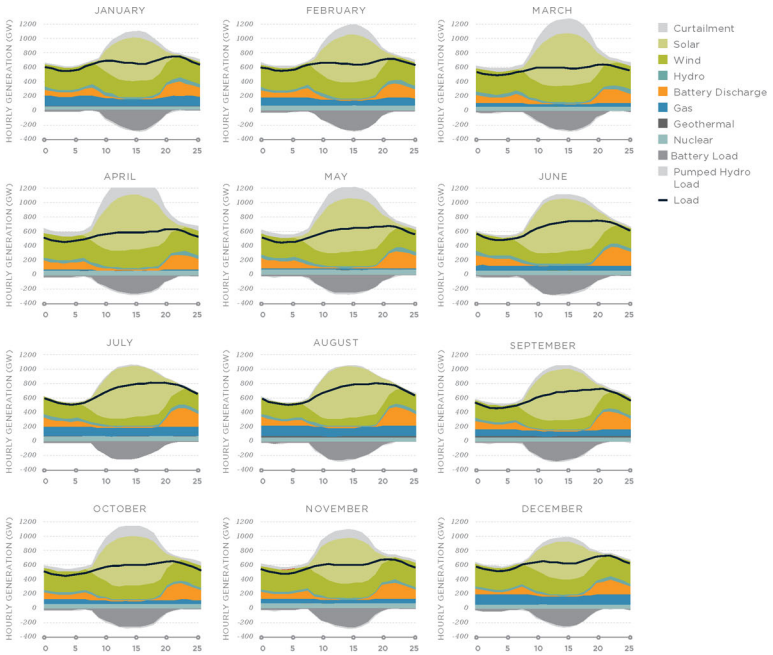


FIGURE 28.

Hourly national grid dispatch in each month, averaged over the 7 weather years, under the DRIVE Clean scenario.

In summary, retaining existing hydropower capacity and nuclear power capacity (after accounting for planned retirements) and about half of existing fossil fuel capacity, combined with 425 GW (2,650 GWh) of new battery storage and 1,560 GW of new wind and solar, is sufficient to meet U.S. electricity demand dependably with a 90% clean grid in 2035, even with higher loads due to aggressive transportation electrification. Total capital investments in new renewables, battery storage, and transmission through 2035 is approximately $2.6 trillion. Under the DRIVE Clean scenario, all existing coal plants are retired by 2030, and no new fossil fuel plants are built beyond those already under construction. During normal periods of generation and demand, wind, solar, and batteries provide 72% of total annual generation, while hydropower and nuclear provide 16%. During periods of high demand and/or low renewable generation, existing natural gas plants (primarily combined-cycle

plants) cost-effectively compensate for remaining mismatches between demand and renewables-plus-battery generation—accounting for about 10% of total annual electricity generation.

Under the DRIVE Clean scenario, increased electrification and renewable energy and battery storage deployments require investments mainly in new transmission spurs connecting renewable generation to existing high-capacity transmission, rather than new investments in bulk transmission. While the DRIVE Clean scenario requires about three times more spurline investment than the No New Policy scenario, the total transmission requirements in DRIVE Clean add only $0.2 cents/kWh to total system costs. Recent studies that account for low renewable energy and battery storage costs indicate similar findings (Jayadev et al. 2020). Studies that assume much higher renewable energy costs or do not consider substantial battery storage find higher levels of additional bulk transmission are required (Clack et al. 2017, NREL 2012). Further work is needed to understand transmission needs more precisely.

5
CONCLUSIONS, CAVEATS, AND FUTURE WORK

As the nation's largest emitter of GHGs and a leading source of harmful air pollutants, the transportation sector must move rapidly to reduce pollution and transition to electric vehicles. In this analysis, we show that switching to all-electric light-duty vehicles, medium-duty vehicles, and heavy-duty trucks can be cost-effective for consumers while yielding numerous national benefits. Transitioning to 100% electric LDV sales by 2030 and 100% electric MDV and HDT sales by 2035 results in $2.7 trillion in cumulative consumer cost savings, and $1.3 trillion in environmental and human health cost savings through 2050.

Other industrialized nations are charging ahead with electric vehicle adoption, spurred by strong public policy, strategic infrastructure investments, and expanded consumer engagement. As vehicle electrification expands globally, the United States needs increased ambition and leadership to remain competitive as a vehicle and battery manufacturer. With strong policies in the near term, the U.S. auto industry can pivot quickly to become a global leader in vehicle electrification, gain market share, and sustain and create jobs. The United States can also improve public health, help address the climate crisis, and save consumers trillions of dollars. The benefits of such a shift speak for themselves, as do the costs of inaction.

Like all analyses, ours has limitations. The DRIVE Clean scenario is not a projection; rather, it is intended to illustrate the potential health, environmental, and economic benefits of accelerating EV sales in the next 10–15 years while moving to a 90% clean electric grid. Although this report describes the system characteristics needed to accommodate high levels of renewable generation and demand-side electrification, it does not address the institutional, market, and regulatory changes needed to facilitate such a transformation. Specifically, it does not evaluate the political, societal, or consumer-adoption issues surrounding the DRIVE Clean scenario targets. A supporting policy report from Energy Innovation offers recommendations that address some barriers to such a transition, but these factors should be explored further in future analyses to inform decision making.

In addition, we do not evaluate the broader portfolio of clean vehicle technologies that could decarbonize the transportation sector. Other technologies, such as hydrogen, can and may support transportation decarbonization efforts across all vehicle classes in the future. We also exclude consideration of other mobility measures—such as public transit, car sharing, and smart urban planning to reduce vehicle miles traveled—but these measures are critical adjuncts to electrification for holistically decarbonizing the transportation sector.

We also recognize that the transportation sector has contributed to economic and racial inequities and disproportionate health impacts in the United States. In the shift to electrified transportation, attention must be paid to approaches that ensure a more equitable transition for all people, regardless of race, income, or geographic location.

Finally, although we assess operational feasibility of the U.S. power system using weather-synchronized load and generation data, further work is needed to advance our understanding of other facets of a 90% clean power system with increasing vehicle, building, and industrial electrification. Although this analysis does not attempt a full power-system reliability

assessment, we perform scenario and sensitivity analysis to ensure that demand is met in all periods, including during extreme weather events and periods of low renewable energy generation. Although the capacity-expansion modeling (ReEDS) required that clean resources contribute 90% of annual generation in 2035, the hourly operational model (PLEXOS) simulated roughly 88% clean generation, primarily due to higher curtailment of wind and solar. PLEXOS model dispatch decisions were based on the variable cost of generation and did not consider the carbon free or non-carbon free nature of the generation source. In an electricity market with a 90% clean energy constraint, as modeled in the DRIVE Clean scenario, clean energy may bid negative prices in certain hours in order to get dispatched and meet the 90% constraint. We utilize ReEDS to effectively model this 90% clean electricity share, while the main purpose of our simulation in PLEXOS is to evaluate operational feasibility. For this reason, we did not simulate the same 90% clean energy constraint in PLEXOS, which might have required clean energy to bid negative prices in order to get dispatched.

This report suggests that the high-renewables, high-electrification vision of the DRIVE Clean scenario results in a dependable U.S. electricity grid. Importantly, our study does not assume the availability of flexible loads such as "smart" or managed electric vehicle charging or demand response from building loads. These technologies and systems offer additional flexibility to further increase system reliability and efficiency and reduce costs under the DRIVE Clean scenario. Further description of study limitations and a more robust narrative of detailed results can be found in the appendix.

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" Pour ce qui est de l'avenir, il ne s'agit pas de le prévoir, mais de le rendre possible. " – **Antoine de Saint Exupéry**, *Citadelle*, 1948

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Summary for Policymakers

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Chapter 1

Understanding the impacts of 1.5°C global warming above pre-industrial levels and related global emission pathways in the context of strengthening the response to the threat of climate change, sustainable development and efforts to eradicate poverty.

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Chapter 2

Showing how emissions can be brought to zero by mid-century stay within the small remaining carbon budget for limiting global warming to 1.5°C.

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Why is it necessary and even vital to maintain the global temperature increase below 1.5˚C versus higher levels? Adaptation will be less difficult. Our world will suffer less negative impacts on intensity and frequency of extreme events, on resources, ecosystems, biodiversity, food security, cities, tourism, and carbon removal.

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Chapter 4

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Chapter 5

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Glossary

This glossary defines some specific terms as the Lead Authors intend them to be interpreted in the context of this report. Blue, italicized words indicate that the term is defined in the Glossary.

Note that subterms are in italics beneath main terms.

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The Intergovernmental Panel on Climate Change

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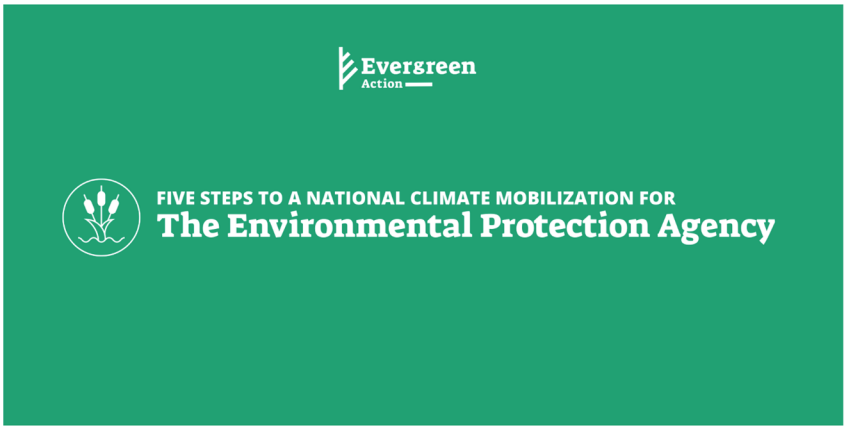
Evergreen Action

5 Action Steps for the EPA to Lead a National Mobilization to Defeat the Climate Crisis

Evergreen Action Dec 17, 2020 · 5 min read



Today, President-elect Biden selected a strong leader with on-the-ground climate experience to head up the Environmental Protection Agency. Michael Regan has led the

It's hard to imagine a bigger sea change in EPA leadership than the switch from a coal lobbyist to a proven state leader on climate action. Donald Trump's EPA laid waste to environmental protections. Michael Regan has the experience necessary to restore the EPA to its mission and go on offense to defeat the climate crisis. He reached a nationally renowned settlement on coal ash pollution, and he made North Carolina into a leading state on environmental justice. After decades of environmental policy disproportionately impacting communities of color, it is historic for the Biden Administration to nominate the first Black male EPA Administrator.

Under Michael Regan, the EPA can once again lead on climate policy. The agency must utilize the Clean Air Act to move our economy towards 100% clean energy–enforcing stringent decarbonization standards in the power, transportation, buildings and industrial sectors. The agency must also deliver on Biden's promise to allot 40% of federal green investments in disadvantaged communities through a revamped national Equity Map.

It will not be enough for us to just turn back the clock to 2016. The Environmental Protection Agency has much damage to undo, but it also has an unprecedented opportunity to defeat the climate crisis and create millions of good-paying jobs in the process.

Michael Regan served at the EPA for over a decade under two different presidents. During his time, he served as national program manager for the Office of Air Quality Planning and Standards. He now serves as Secretary of North Carolina's Department of Environmental Quality. Recently, he forced a settlement for Duke Energy, a massive national energy corporation, to excavate 80 million tons of coal ash, the largest coal ash clean up in the nation.

As President-elect Biden begins an all-out government mobilization to defeat the climate crisis, Evergreen Action is releasing roadmaps for key federal agencies to contribute to the effort. Below are 5 concrete actions the EPA can take to go on the offensive in the mobilization to defeat the climate crisis:

The EPA has the legal authority to regulate greenhouse gases, along with particulate and criteria air pollution, under the Clean Air Act. In order to move toward President-elect Biden's goals of a carbon pollution-free power sector by 2035 and a net-zero economy by 2050, the EPA must move immediately to develop new regulations under this authority to block the construction of new polluting power plants, and to limit carbon emissions from existing plants. These actions should be undertaken simultaneously with the EPA's immediate efforts to reverse Trump administration clean air rollbacks, and to issue new rules for mercury and air toxics, ozone, and more — limiting these deadly pollutants in every community and prioritizing reductions in disadvantaged communities, in particular those facing disparate health impacts and significant cumulative pollution burdens.

2. Develop Ambitious New Standards for 100% Clean Cars

The Clean Air Act also gives the EPA authority to regulate emissions from cars, trucks, and other vehicles. In order to accelerate a nationwide transition to 100% clean zero-emission cars, the EPA should work with the National Highway Traffic Safety Administration (NHTSA), states, auto workers, automotive manufacturing industries, and environmental advocates to develop ambitious new emissions standards for all vehicle classes. The EPA should then also look to other existing authorities, like the Renewable Fuel Standard (RFS), to further help drive vehicle and transportation decarbonization. And the Biden administration must prioritize investments in electric vehicle manufacturing and infrastructure in its negotiations with Congress over economic recovery. Further, EPA should partner with the Departments of Transportation and Housing and Urban Development to accelerate deployment of new vehicle charging infrastructure and other advanced clean energy infrastructure in support of rapidly and successfully meeting the administration's ambitious new 100% Clean Car Standard.

3. Launch a National Equity Mapping initiative to Drive Policies and Investments in Environmental and Economic Justice for Disadvantaged Communities

One of the first and most critical steps that the EPA can take to enable all agencies to prioritize justice for front-line and marginalized communities should be to launch the development of a revamped federal Equity Mapping tool to measure the overlapping, cumulative harms of pollution, climate impacts, poverty, and systemic racism. This

would help enable President-elect Biden's campaign pledge to direct 40% of clean energy investments toward disadvantaged communities, by presenting detailed localized information about the cumulative impacts of environmental harms, economic inequality, and other socio-economic indicators. The development of the mapping initiative should include extensive consultation with environmental justice advocacy groups and front-line community members about which data will be used in the map's creation as well as how the map will be used to direct resources. This must be part of a comprehensive federal agenda for environmental justice in which EPA leadership must be central.

4. Reverse the Trump Administration's Pro-Polluter Environmental Attacks

The Trump administration has rolled back more than 100 environmental protection regulations in order to advance their fossil-fueled, pro-polluter agenda, most of which impacted EPA policies. Starting on Day One, the Biden administration should begin reversing Trump's efforts to turn the EPA into the Polluter Protection Agency, and should replace Trump's industry-friendly rules with real protections for our climate, natural resources, and public health. The Biden administration should start this process by prioritizing the most high-impact rules in terms of carbon emissions, including rollbacks related to power plant pollution, methane leaks, vehicle emissions, and hydrofluorocarbon (HFC) restrictions, and by directing the EPA to fulfill its core mission by strengthening its enforcement of polluter violations of environmental law.

5. Use Clean Air Act Authority to Drive Deep Decarbonization of the Buildings and Industrial Sectors

According to EPA data, direct and indirect emissions from buildings and the industrial sector — which includes heating and cooling, construction, production of materials like steel and concrete, and more — together account for roughly 34% of all US greenhouse gas emissions, along with other pollutants like nitrogen dioxide. The agency should use its authority under the Clean Air Act to develop new rules to set ambitious standards to accelerate the decarbonization of buildings and industry and improve indoor air quality during this time of pandemic. These should include new standards for buildings, mechanical equipment like hot water heaters and HVAC heat pumps, as well as home appliances, and industrial manufacturing equipment and processes. EPA should partner

through consumer incentives and state and local building codes.

Epa Environment Climate Change Climate Joe Biden

BRIEFING ROOM

FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies

APRIL 22, 2021 • STATEMENTS AND RELEASES

Building on Past U.S. Leadership, including Efforts by States, Cities, Tribes, and Territories, the New Target Aims at 50-52 Percent Reduction in U.S. Greenhouse Gas Pollution from 2005 Levels in 2030

Today, President Biden will announce a new target for the United States to achieve a 50-52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030 – building on progress to-date and by positioning American workers and industry to tackle the climate crisis.

The announcement – made during the Leaders Summit on Climate that President Biden is holding to challenge the world on increased ambition in combatting climate change – is part of the President's focus on building back better in a way that will create millions of good-paying, union jobs, ensure economic competitiveness, advance environmental justice, and improve the health and security of communities across America.

On Day One, President Biden fulfilled his promise to rejoin the Paris Agreement and set a course for the United States to tackle the climate crisis at home and abroad, reaching net zero emissions economy-wide by no later than 2050. As part of re-entering the Paris Agreement, he also launched a whole-of-government process, organized through his National Climate Task Force, to establish this new 2030 emissions target – known as the "nationally determined contribution" or "NDC," a formal submission to the United Nations Framework Convention on Climate Change (UNFCCC). Today's announcement is the product of this government-wide assessment of how to make the most of the opportunity combatting climate change presents.

PUSHING PROGRESS, CREATING JOBS, AND ACHIEVING JUSTICE

The United States is not waiting, the costs of delay are too great, and our nation is resolved to act now. Climate change poses an existential threat, but responding to this threat offers an opportunity to support good-paying, union jobs, strengthen America's working communities, protect public health, and advance environmental justice. Creating jobs and tackling climate change go hand in hand – empowering the U.S. to build more resilient infrastructure, expand access to clean air and drinking water, spur American technological innovations, and create good-paying, union jobs along the way.

To develop the goal, the Administration analyzed how every sector of the economy can spur innovation, unleash new opportunities, drive competitiveness, and cut pollution. The target builds on leadership from mayors, county executives, governors, tribal leaders, businesses, faith groups, cultural institutions, health care organizations, investors, and communities who have worked together tirelessly to ensure sustained progress in reducing pollution in the United States.

Building on and benefiting from that foundation, America's 2030 target picks up the pace of emissions reductions in the United States, compared to historical levels, while supporting President Biden's existing goals to create a carbon pollution-free power sector by 2035 and net zero emissions economy by no later than 2050. There are multiple paths to reach these goals, and the U.S. federal, state, local, and tribal governments have many tools available to work with civil society and the private sector to mobilize investment to meet these goals while supporting a strong economy.

SUPPORTING AMERICAN WORKERS

This target prioritizes American workers. Meeting the 2030 emissions target will create millions of good-paying, middle class, union jobs – line workers who will lay thousands of miles of transmission lines for a clean, modern, resilient grid; workers capping abandoned wells and reclaiming mines and stopping methane leaks; autoworkers building modern, efficient, electric vehicles and the charging infrastructure to support them; engineers and construction workers expanding carbon capture and green hydrogen to forge cleaner steel and cement; and farmers using cutting-edge tools to make American soil the next frontier of carbon innovation.

The health of our communities, well-being of our workers, and competitiveness of our economy requires this quick and bold action to reduce greenhouse gas emissions. We must:

- **Invest in infrastructure and innovation.** America must lead the critical industries that produce and deploy the clean technologies that we can harness today – and the ones that

we will improve and invent tomorrow.

- **Fuel an economic recovery that creates jobs.** We have the opportunity to fuel an equitable recovery, expand supply chains and bolster manufacturing, create millions of good-paying, union jobs, and build a more sustainable, resilient future.
- **Breathe clean air and drink clean water and advance environmental justice.** We can improve the health and well-being of our families and communities – especially those places too often left out and left behind.
- **Make it in America.** We can bolster our domestic supply chains and position the U.S. to ship American-made, clean energy products — like EV batteries – around the world.

MEETING THE MOMENT

The target is consistent with the President's goal of achieving net-zero greenhouse gas emissions by no later than 2050 and of limiting global warming to 1.5 degrees Celsius, as the science demands. To develop the target, the Administration:

- **Used a whole-of-government approach:** The NDC was developed by the National Climate Task Force using a whole-of-government approach, relying on a detailed bottom-up analysis that reviewed technology availability, current costs, and future cost reductions, as well as the role of enabling infrastructure. Standards, incentives, programs, and support for innovation were all weighed in the analysis. The National Climate Task Force is developing this into a national climate strategy to be issued later this year.
- **Consulted important and diverse stakeholders:** From unions that collectively bargain for millions of Americans who have built our country and work to keep it running to groups representing tens of millions of advocates and young Americans, the Administration listened to Americans across the country. This also included groups representing thousands of scientists; hundreds of governmental leaders like governors, mayors, and tribal leaders; hundreds of businesses; hundreds of schools and institutions of higher education; as well as with many specialized researchers focused on questions of pollution reduction.
- **Explored multiple pathways across the economy**: The target is grounded in analysis that explored multiple pathways for each economic sector of the economy that produces CO_2 and non-CO_2 greenhouse gases: electricity, transportation, buildings, industry, and lands.

Each policy considered for reducing emissions is also an opportunity to support good jobs and improve equity:

- The United States has set a goal to reach **100 percent carbon pollution-free electricity by 2035**, which can be achieved through multiple cost-effective pathways each resulting in meaningful emissions reductions in this decade. That means good-paying jobs deploying carbon pollution-free electricity generating resources, transmission, and energy storage and leveraging the carbon pollution-free energy potential of power plants retrofitted with carbon capture and existing nuclear, while ensuring those facilities meet robust and rigorous standards for worker, public, environmental safety and environmental justice.

- The United States can create good-paying jobs and **cut emissions and energy costs for families by supporting efficiency upgrades and electrification in buildings** through support for job-creating retrofit programs and sustainable affordable housing, wider use of heat pumps and induction stoves, and adoption of modern energy codes for new buildings. The United States will also invest in new technologies to reduce emissions associated with construction, including for high-performance electrified buildings.

- The United States can **reduce carbon pollution from the transportation sector** by reducing tailpipe emissions and boosting the efficiency of cars and trucks; providing funding for charging infrastructure; and spurring research, development, demonstration, and deployment efforts that drive forward very low carbon new-generation renewable fuels for applications like aviation, and other cutting-edge transportation technologies across modes. Investment in a wider array of transportation infrastructure, including transit, rail, and biking improvements, will make more choices available to travelers.

- The United States can **reduce emissions from forests and agriculture and enhance carbon sinks** through a range of programs and measures including nature-based solutions for ecosystems ranging from our forests and agricultural soils to our rivers and coasts. Ocean-based solutions can also contribute towards reducing U.S. emissions.

- The United States can **address carbon pollution from industrial processes** by supporting carbon capture as well as new sources of hydrogen—produced from renewable energy, nuclear energy, or waste—to power industrial facilities. The government can use its procurement power to support early markets for these very low- and zero-carbon industrial goods.

- The United States will also reduce non-CO2 greenhouse gases, including methane, hydrofluorocarbons and other potent short-lived climate pollutants. Reducing these pollutants delivers fast climate benefits.

- In addition, the United States will **invest in innovation** to improve and broaden the set of solutions as a critical complement to deploying the affordable, reliable, and resilient clean technologies and infrastructure available today.

America must act— and not just the federal government, but cities and states, small and big business, working communities. Together, we can seize the opportunity to drive prosperity, create jobs, and build the clean energy economy of tomorrow.

###

★ ★ ★

About the Leaders Summit on Climate

Share

What is the Leaders Summit on Climate?

On March 26, **the President invited 40 world leaders to participate in the virtual Leaders Summit on Climate** April 22-23, 2021.

As the U.S. Government reenters the global climate fight, President Biden convened this summit early in his presidency to ensure close coordination with key players in the international community at the highest levels of government. This summit aimed at setting the world up for success on multiple fronts as we work to address the climate crisis, including emissions reductions, finance, innovation and job creation, and resilience and adaptation.

The Summit was a key milestone on the road to the UN Climate Change Conference (COP26) this November in Glasgow and was designed to increase the chances for meaningful outcomes on global climate action at COP26. It reconvened the Major Economies Forum (MEF) on Energy and Climate, a U.S.-led initiative that played a vital role in delivering the Paris Agreement. In addition to the major economies, the President brought other crucial voices into the conversation by inviting leaders of countries that are key stakeholders in the climate fight, including those that have demonstrated strong climate leadership, are especially vulnerable to climate impacts, or are charting innovative pathways to a net-zero economy.

Schedule

What are the key themes of the Summit?

- Galvanizing efforts by the world's major economies to **reduce emissions during this critical decade** to keep the goal of limiting warming to 1.5 degree Celsius within reach.
- Mobilizing **public and private sector finance to drive the net-zero transition and to help vulnerable countries** cope with climate impacts.
- The **economic benefits of climate action, with a strong emphasis on job creation**, and the importance of ensuring all communities and workers benefit from the transition to a new clean energy economy.
- **Spurring transformational technologies** that can help reduce emissions and adapt to climate change, while also creating enormous new economic opportunities and building the industries of the future.
- **Showcasing subnational and non-state actors** that are committed to green recovery and an equitable vision for limiting warming to 1.5 degree Celsius, and are working closely with national governments to advance ambition and resilience.
- Discussing opportunities to strengthen capacity to protect lives and livelihoods from the impacts of climate change, address the **global security challenges posed by climate**

change and the impact on readiness, and address the role of **nature-based solutions** in achieving net zero by 2050 goals.

Who did the President invite to the Summit?

The primary objective of the Summit was to encourage the world's major economies—and especially the original members of the Major Economies Forum on Climate and Energy, which together represent 80 percent of global emissions and 80 percent of global GDP—to enhance ambition to keep the goal of limiting warming to 1.5 degrees Celsius within reach. To ensure the Summit captured as many diverse viewpoints as possible, the United States invited additional countries that are key voices in the climate fight—for example, some that are especially vulnerable to climate impacts or that are charting particularly innovative pathways to a net-zero economy.

The United States seeks to engage all countries to explore areas for cooperation on addressing the climate crisis. The Summit is only one of several major climate-related events in the run-up to COP-26, which will be a global event. We look forward to working with governments around the world to raise the level of global ambition to meet the climate challenge and welcome public statements from all governments in support of the Summit's objective of enhancing global ambition on climate change.

The President invited the following leaders to participate in the Summit:

- Prime Minister Gaston Browne, Antigua and Barbuda
- President Alberto Fernandez, Argentina
- Prime Minister Scott Morrison, Australia
- Prime Minister Sheikh Hasina, Bangladesh
- Prime Minister Lotay Tshering, Bhutan
- President Jair Bolsonaro, Brazil
- Prime Minister Justin Trudeau, Canada
- President Sebastián Piñera, Chile

- President Xi Jinping, People's Republic of China
- President Iván Duque Márquez, Colombia
- President Félix Tshisekedi, Democratic Republic of the Congo
- Prime Minister Mette Frederiksen, Denmark
- President Ursula von der Leyen, European Commission
- President Charles Michel, European Council
- President Emmanuel Macron, France
- President Ali Bongo Ondimba, Gabon
- Chancellor Angela Merkel, Germany
- Prime Minister Narendra Modi, India
- President Joko Widodo, Indonesia
- Prime Minister Benjamin Netanyahu, Israel
- Prime Minister Mario Draghi, Italy
- Prime Minister Andrew Holness, Jamaica
- Prime Minister Yoshihide Suga, Japan
- President Uhuru Kenyatta, Kenya
- President David Kabua, Republic of the Marshall Islands
- President Andrés Manuel López Obrador, Mexico
- Prime Minister Jacinda Ardern, New Zealand
- President Muhammadu Buhari, Nigeria
- Prime Minister Erna Solberg, Norway
- President Andrzej Duda, Poland
- President Moon Jae-in, Republic of Korea
- President Vladimir Putin, The Russian Federation
- King Salman bin Abdulaziz Al Saud, Kingdom of Saudi Arabia
- Prime Minister Lee Hsien Loong, Singapore

- President Matamela Cyril Ramaphosa, South Africa
- President Pedro Sánchez, Spain
- President Recep Tayyip Erdoğan, Turkey
- President Sheikh Khalifabin Zayed Al Nahyan, United Arab Emirates
- Prime Minister Boris Johnson, United Kingdom
- President Nguyễn Phú Trọng, Vietnam

TAGS

Leaders Summit on Climate

WORLD RESOURCES INSTITUTE

Does Biden's American Jobs Plan Stack Up on Climate and Jobs?

April 1, 2021 By **Joel Jaeger**, **Katrina McLaughlin**, **Jillian Neuberger** and **Carrie Dellesky** Cover Image by: Wayne National Forest/Flickr

Commentary

Topic **Climate** *Region* **North America**

President Biden unveiled a new $2 trillion American Jobs Plan on Wednesday, March 31, focused on infrastructure, the care economy, climate and, as the name implies, creating desperately needed good jobs. Previous U.S. COVID-19 spending stimulus packages were focused on short-term emergency response, and too much of it propped up the business-as-usual, polluting economy.

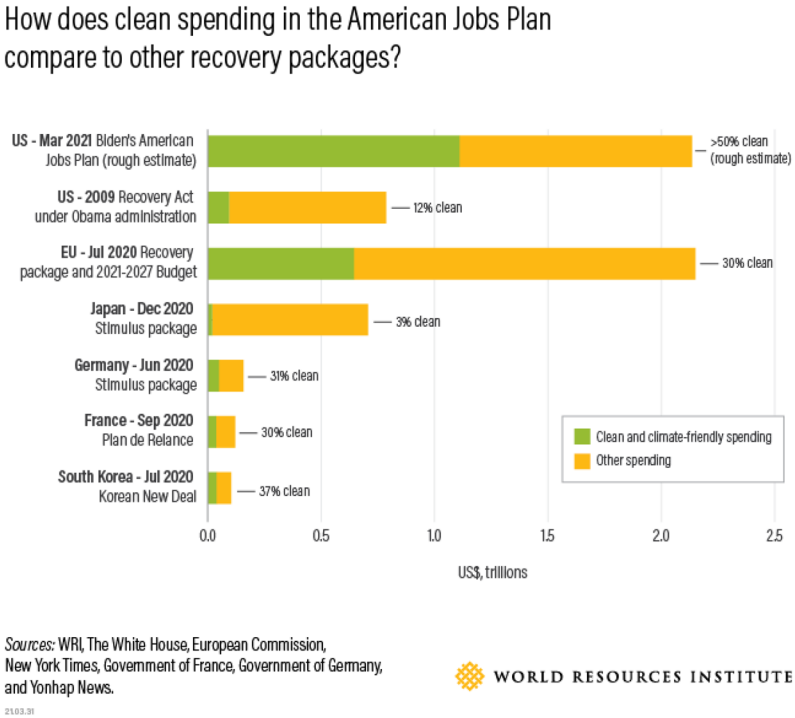
This new proposal is designed to promote longer-term economic recovery and keep the United States competitive while responding to the economic devastation from the coronavirus pandemic and the climate crisis.

If the proposal becomes law this summer, as Biden hopes it will, it would simultaneously create millions of good-paying jobs and be the most important climate

legislation in U.S. history. Not all of the specific investment amounts have been identified yet, but it appears that at least $1 trillion would go to sectors that fall under the broad umbrella of climate change, clean energy and environmental justice.

Biden's jobs proposal would help the United States regain its status as an international leader in climate policy and in clean energy industries. It proposes more spending aimed at addressing climate change and protecting the environment than any other countries have announced in their COVID recovery packages.

The only other economy with a similar level of ambition is the European Union, which is requiring that 30% of its economic recovery package and 2021-2027 budget be climate-friendly. In this U.S. proposal, it would be about 50%.



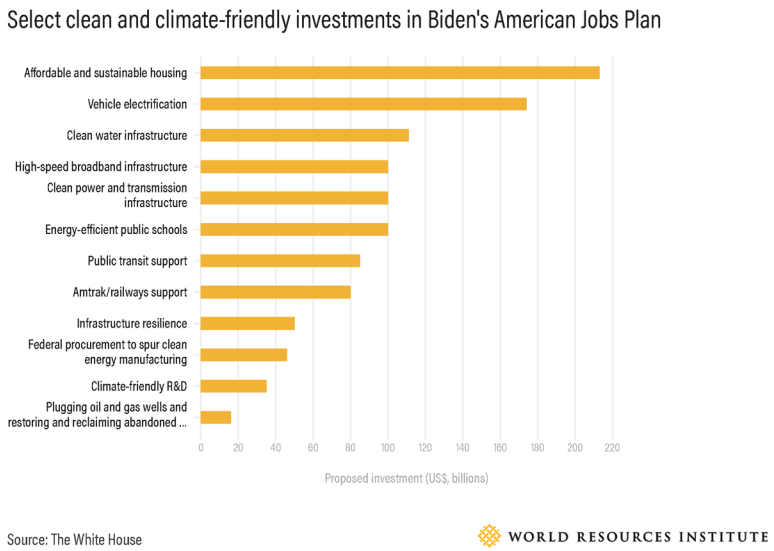
The Jobs Opportunity

Evidence shows that climate-friendly investments are an effective stimulus. $1 invested in clean infrastructure returns far more than $1 to the economy. A plethora of recent studies have outlined the huge job creation potential of climate-friendly stimulus in the United States. Investing in clean energy can create 2-3 times more jobs than investing the same amount in fossil fuels; it requires a lot of labor to retrofit buildings to be more energy efficient or to install solar panels.

When the United States invested $90 billion in clean energy as part of the 2009 Recovery Act, it supported 900,000 job-years (full time jobs over one year) in clean energy fields from 2009 to 2015. Other labor-intensive and climate-smart activities, like restoring nature-based infrastructure, also provide economic output and job creation benefits far greater than the scale of investment.

Climate-friendly stimulus has the potential to not only spur job growth but to create quality employment opportunities in a well-paid workforce and safe, healthy and equitable workplaces. Creating quality, American, union jobs is at the core of the Biden plan, which embraces labor priorities like prevailing wage standards, project labor agreements, apprenticeships and training programs, empowering workers to organize, and addressing workplace bias, discrimination and harassment.

Below we outline the key climate provisions of Biden's proposed infrastructure package.



Affordable and Sustainable Housing

The plan proposes spending $213 billion to produce, preserve and retrofit more than two million affordable and sustainable places to live, with a particular emphasis on providing housing to underserved communities across the country. It calls for reform of zoning laws that make cities more unequal and more sprawled.

Investments in building efficiency and resilience to climate change hazards have been proven to be an effective way to quickly create jobs. The United States should be able to quickly ramp up building retrofits through existing programs — such as the Weatherization Assistance Program and the State Energy Program — as it did with the 2009 Recovery Act, when investments in building efficiency created tens of thousands of jobs. More efficient buildings can also save money for residents and businesses, particularly important now since millions of Americans are behind on utility bills due to COVID-19's economic impact.

The proposal also includes modernizing and improving the energy-efficiency and resiliency of schools and federal buildings, among others, presenting another opportunity to create jobs and lower energy demand.

Sustainable Transportation

The plan proposes investing $174 billion to electrify the nation's transportation system while creating good jobs in manufacturing and construction. This includes providing sales rebates and tax incentives to encourage drivers to switch to electric vehicles (EVs), building a national network of 500,000 EV chargers by 2030, and electrifying the federal fleet including the Postal Service. Electric vehicles save consumers money on gas, improve health by reducing air pollution, and are better for the climate. The IEA finds that EV charging infrastructure creates more jobs than investing in highways or in traditional car manufacturing. The proposal also includes electrifying 50,000 transit vehicles and at least 20% of the school bus fleet (about 96,000 buses) through a new clean school bus program at the Environmental Protection Agency. School buses are critical to school accessibility across the country and electrifying these vehicles will

create cleaner and healthier air for kids, reduce greenhouse gas emission and improve communities' energy resilience through the bus batteries.

The plan proposes investing $85 billion to modernize and expand public transit systems and $80 billion to support Amtrak in repairing and modernizing railways. Public transit has been an effective job creator: When U.S. states had the choice of where to spend 2009 Recovery Act transportation money, each dollar spent on public transit projects created 75% more job-hours than a dollar spent on highways. Public transit investments also support cost savings for everyone in the economy by reducing travel costs, reducing traffic and increasing business productivity — all of which have a long-term positive effect on jobs.

Biden's proposal includes spending on highways and bridges as well, but is focused on road repair rather than building new roads. The plan calls for driving innovation in sustainable materials by procuring cleaner cement and steel for these projects, and includes $20 billion to improve road safety and reduce traffic fatalities for pedestrians and cyclists.

Transmission, Clean Energy and Electric Grid Modernization

The plan proposes $100 billion for power infrastructure, including significant investments in transmission, tax credits, clean energy procurement by the federal government, and grant support to state, local and tribal governments. It suggests that these investments be accompanied by an energy efficiency and clean electricity standard to reach 100% carbon-free power by 2035. Few details are provided, but such a standard would be transformative.

The plan proposes to establish a new investment tax credit for transmission lines, with a goal of building out at least 20 GW of high-voltage capacity lines. It would extend for 10 years the investment and production tax credits for clean energy generation and storage, with expanded direct-pay options — providing these tax credits as direct payments to clean energy developers, overcoming challenges with existing tax equity financing measures. Taken together, these measures provide critical financial incentives and policy certainty for clean energy developers.

The measure also proposes a new Grid Deployment Authority at the Department of Energy, which could make it easier and faster to find the right locations and get the permits to build transmission infrastructure. Delays in transmission deployment cost system operators billions every year and are a barrier to additional renewable energy development. New transmission and grid modernization can help the United States utilize the most productive renewable energy sites and diversify the location of our resources, lowering the costs of the energy transition while increasing grid resiliency.

The ambitious investments in this proposal are necessary to accelerate decarbonization of the U.S. electricity system. The costs of renewable energy technologies have declined dramatically (71% for onshore wind and 90% for utility-scale solar) since 2009 and the United States added new wind, utility-scale and rooftop solar and battery storage at record levels in 2020. Nonetheless, we need to build zero-carbon generating capacity at double or triple this rate over the coming decade to meet midcentury decarbonization targets, according to recent expert reports.

Next Generation Industries, Advanced Manufacturing and RD&D

Biden's plan also goes a long way to tackle emissions from industry and manufacturing, which is the most difficult part of the economy to decarbonize. It includes $580 billion to strengthen U.S. manufacturing. This includes $180 billion specifically for Research, Design and Development (RD&D) on emerging technologies, $35 billion of which is focused on climate science and innovation. The measure would also create a dedicated research agency — the Advanced Research Projects Agency-Climate (ARPA-C) — within the DOE for climate research and advanced technologies.

Other measures include extending the 48C tax credit for advanced manufacturing (an oversubscribed program in the 2009 recovery act that helped to increase domestic wind manufacturing) and $15 billion in demonstration projects for a number of technologies including clean hydrogen, advanced nuclear and energy storage.

In line with existing bipartisan legislation and the House Select Committee on the Climate Crisis's recommendation, Biden's plan supports large-scale carbon sequestration efforts which will capture CO_2 directly from emission sources and from

ambient air. Studies show that even partial deployment of the carbon capture and storage plants required to meet our climate goals could create over 61,000 American jobs through 2035.

To accelerate carbon capture and permanent CO_2 storage, the plan aims to reform and expand the bipartisan 45Q tax credit to make it direct pay and easier to use for hard-to-decarbonize industrial applications, direct air capture, and retrofits of power plants.

If passed, this would be a historic investment in advanced manufacturing and the next generation industries needed to decarbonize the U.S. economy. Investments in RD&D are proven job creators and sources of long-term economic growth, with the potential to increase future competitiveness, advance energy security and work towards emission reductions in hard-to-abate sectors.

Infrastructure Resilience

President Biden's plan calls for $50 billion for improving infrastructure resilience across the electric grid, food systems, health systems, urban infrastructure and transportation infrastructure. Part of that investment is in retrofitting buildings to make them better able to withstand climate change impacts.

This could be done by incorporating materials and standards that can better stand up to more severe storms or using roofing materials that can withstand wildfires. As climate change disproportionately affects marginalized communities, part of the plan focuses on building resilient infrastructure in vulnerable communities most at risk of climate impacts disasters. The plan also aims to empower local leaders to shape some of these project funds.

Nature-Based Infrastructure

Part of that $50 billion for resilient infrastructure would go to restoring nature-based infrastructure — our lands, forests, coastal and ocean resources, wetlands and watersheds that families and businesses rely on for their lives and livelihoods. The plan calls on Congress to invest in protection from extreme weather events like wildfires,

floods and hurricanes that cost the United States $95 billion in damage to homes, businesses and public infrastructure in 2020 alone.

Biden also asks Congress to support agricultural resources management and climate-smart technologies, and the protection and restoration of major land and water resources like Florida's Everglades and the Great Lakes. The workforce to implement these proposals could come through the new Civilian Climate Corps, for which Biden calls for a $10 billion investment to provide Americans with good-paying union jobs while conserving public lands and waters, bolstering community resilience and advancing environmental justice.

Biden's bet on nature-based infrastructure would also pay big dividends for carbon removal. The country's natural and working lands like forests, farms and wetlands collectively remove 12% of annual U.S. greenhouse gas emissions from the atmosphere already. They have the potential to remove up to 1 billion tons of additional carbon dioxide per year with smart measures to promote conservation, restoration and sustainable land management.

Creating Opportunities in Distressed and Disadvantaged Communities

The American Jobs Plan includes multiple initiatives intended to reduce inequality and assist disadvantaged communities, including communities that formally relied on fossil fuels and those impacted by local pollution. The plan proposes an immediate investment of $16 billion in plugging oil and gas wells and restoring and reclaiming abandoned coal, hardrock and uranium mines, as well as a $5 billion investment in rehabilitation in Brownfield and Superfund sites.

It also involves investing in programs such as the Appalachian Regional Commission's POWER grant program, the Economic Development Agency's Public Works program, Department of Energy grants for idle factories and "Main Street" revitalization efforts through United States Departments of Housing and Urban Development and Agriculture. These programs support new infrastructure, economic

development and diversification in communities that have faced significant disinvestment.

Such investments can create jobs and bolster energy transition communities while mitigating methane emissions and addressing local environmental impacts on water, soils and air. Research conducted last year suggests that plugging 500,000 wells could create up to 120,000 jobs at a cost of between $12-24 billion. The oil and gas industry lost over 100,000 jobs last year, and this program could be a lifeline for fossil fuel workers (and the local and state economies that depend on them).

And Much More

The American Jobs Plan is expansive. In addition to some of the critical climate spending discussed previously, it includes other priority investments in infrastructure, environment and public health. The proposal would replace 100% of lead pipes and service lines, upgrade and modernize America's water systems and provide affordable, reliable, high-speed broadband to all, to name just a few examples.

The plan also includes the crosscutting commitments to high-road labor standards and safe and equitable workplaces, racial equity, and reaching frontline and underserved communities that must underpin a net-zero transition that ensures prosperity for all. Finally, the American Jobs Plan includes the commitment to supporting state, local and tribal governments that will determine its success across infrastructure priorities and ensure it delivers on the benefits it promises.

Securing a Green, Inclusive Future

President Biden's American Jobs Plan is an ambitious, inclusive and people-first foundation for a clean energy future. It's commitment to building a modern energy system, 100% carbon-pollution free power by 2035 and investing in transmission, will underpin rapid electrification over the next decade. Proposed investments in the power, building and transportation sectors promise to create quality jobs and economic growth while lowering emissions. And its focus on sustainable land use and making infrastructure resilient to climate change is welcome since these important topics don't

usually receive the attention they deserve. While there remains more to be done outside the infrastructure space, this is a monumental proposal to secure the country's future.

Now, all eyes turn to Capitol Hill, where Biden's proposal is expected to be debated and translated into legislation over the coming months and well into the summer. This proposal will be considered along with existing climate legislation and proposals on surface transportation reauthorization. We can expect ongoing debate about the scale of the American Jobs Plan's ambition, but if only one thing is clear it is that Congress must rise to the occasion and be bold because the United States cannot afford to wait any longer to take serious climate action.

EDITOR'S NOTE, 4/5/21: A previous version of this blog post indicated that at least 50% of the proposed U.S. economic recovery package would be climate-friendly. We have since updated the post to indicate that about 50% of it would be climate-friendly.

Relevant Work

STATEMENT: Biden Administration Releases American Jobs Plan with Major Clean Energy Investments

News MARCH 31, 2021

Will Biden's Climate Blitz Sack the Climate Crisis?

Insights FEBRUARY 2, 2021

CLIMATE

April 9, 2021 11:23 PM EDT

United States

Biden budget's $14 bln hike for climate includes big boosts for EPA, science

Reuters, Timothy Gardner, Valerie Volcovici

4 minutes read

U.S. President Joe Biden delivers remarks on tackling climate change prior to signing executive actions in the State Dining Room at the White House in Washington, U.S., January 27, 2021. REUTERS/Kevin Lamarque

U.S. President Joe Biden on Friday proposed $14 billion in spending on initiatives to fight climate change in the 2022 budget, including large cash injections for environmental regulation and science research.

The proposal underscores the administration's ambitions to decarbonizing the economy by 2050 to stem global warming, reversing a policy direction set by former President Donald Trump to slash red tape that hindered fossil fuel production.

Biden's so-called "skinny", or preliminary, budget proposal includes $11.1 billion for the U.S. Environmental Protection Agency, a 21.3% boost over last year's enacted level.

It also includes $10.2 billion for the National Science Foundation, up 20% from the 2021 enacted level, with $500 million of that going to climate and clean energy research. **read more**

An administration official told reporters that the infusion of funding would help restore the federal government's ability to respond to climate change after the previous administration slashed funding for scientific and regulatory agencies.

"Despite the growing threat of climate change, we've cut funding for climate science and technology," the official said, adding the new funding would "help restore the capacity needed to carry out core climate functions, to secure environmental justice for communities that have been left behind and to help developing countries reduce emissions."

The budget includes major new climate change investments and financial support for communities hardest hit by pollution or by the rapid transition away from fossil fuels to renewable energy.

The proposal allocates the largest amount ever to invest marginalized and overburdened communities - $1.4 billion, including $936 million toward a new Accelerating Environmental and Economic Justice initiative at the EPA, as well as $100 million to develop a new community air quality monitoring and notification program.

It also invests $550 million in a program to remediate abandoned oil and gas wells nationwide, tripling current funding, an effort that would create 250,000 jobs.

The request would also increase the Energy Department's budget by 10.2% to $46 billion. Among new programs it would fund, the DOE would invest $1.9 billion to launch a clean energy and workforce initiative that would help the Biden administration meet a goal of decarbonizing the electricity sector by 2035 through a clean electricity and energy efficiency standard.

GLOBAL CLIMATE FINANCE

The budget also gives a boost to U.S. efforts to boost climate aid overseas, a key goal of the administration that seeks to return to a leadership role on climate change ahead of the next U.N. climate summit in Glasgow in November.

Biden will host a climate leaders summit on April 22 and is expected to release a climate finance plan ahead of the online forum.

The budget request calls for a $1.2 billion contribution to the Green Climate Fund, a downpayment of the remaining $2 billion it owes. The Obama administration promised $3 billion to support the fund that assists developing countries reduce emissions and adapt to climate change.

The request also proposes $485 million to support other multilateral climate initiatives, including $100 million for international climate adaptation programs and $691 million for the State Department and U.S. Agency for International Development to assist developing countries in adapting

to climate disruptions.

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POLICY

Biden's EPA pick has experience lifting a discouraged agency

Regan faces turnaround job at EPA similar to task he had at North Carolina agency

Michael Regan, President-elect Joe Biden's nominee for EPA administrator. (North Carolina Department of Environmental Quality)

By **Jessica Wehrman and Benjamin J. Hulac**
Posted December 18, 2020 at 6:00am

Michael Regan, President-elect Joe Biden's nominee for EPA administrator, won kudos for his work to rejuvenate a beleaguered North Carolina Department of Environmental Quality, where morale plummeted under a Republican leadership skeptical about climate science.

If the Senate confirms him, Regan, 44, will be poised for a similar turnaround following the departure of the administration of President Donald Trump, which sought to massively cut EPA's budget and rolled back or weakened dozens of environmental rules and regulations.

"Michael Regan will have a daunting task to reinvigorate EPA. The agency is in shambles, and morale is at rock bottom," said Tim Whitehouse, executive director of Public Employees for Environmental Responsibility, a nonpartisan group that works with federal workers and whistle blowers. "We are at a point in our country's history where EPA is in desperate need of visionary leadership free of corporate influence and excessive political meddling. We hope Mr. Regan can provide that leadership."

After serving as an EPA career official focused on air quality in the Clinton and George W. Bush administrations, Regan went to North Carolina, where the governor, Democrat Roy Cooper, picked him to lead the state agency.

"Michael inherited something of a similar situation when he came into his job in North Carolina," Stan Meiburg, former acting Deputy Administrator of EPA and 39-year veteran of the agency, said in an interview. "The previous administration had cut the budget," he said. "It had been a difficult culture."

and being kind of quiet until you actually did."

Gary Morton, president of the American Federation of Government Employees Council 238, the EPA's largest union, praised Regan's expertise.

"With his understanding of government environmental agencies and the role of enforcement, he is well placed to understand the importance of the boots on the ground — the civil servants, from inspectors to enforcement personnel — to ensure that the EPA can achieve its mission of protecting human health and the environment," he said.

The Trump administration has weakened at least 95 environmental rules since 2017, according to the Environmental Integrity Project, a watchdog group, with many of the biggest rollbacks coming at EPA.

In March, Wheeler, a former coal lobbyist, announced the agency would relax fuel efficiency standards. That same month, EPA, citing the COVID-19 pandemic, said it wouldn't penalize companies that don't follow water and air pollution rules. Then the agency eased in April emissions rules on mercury, a toxic pollutant, despite bipartisan opposition. And just in December, EPA decided against tightening standards

on soot pollution and days later unveiled a rule making it harder for the agency to consider broad health and climate effects.

Regan's nomination comes as EPA employees feel disheartened, and career staff in surveys say units within the agency aren't as effective as they once were.

Jacob Carter, a research scientist in the Center for Science and Democracy at the Union of Concerned Scientists, said the group surveyed federal scientists in 2018 and found that more than 50 percent of the EPA scientists rated their morale as either "poor" or "extremely poor."

Carter said 63 percent of those surveyed said the effectiveness of their office had decreased over the past year. And 65 percent said their personal job satisfaction had decreased over the past year.

Regan, said Carter, "will be walking into a similar situation" as the one he faced at the North Carolina DEQ. "So it will be something that needs to be addressed at the agency," he said.

Duke agreement

As North Carolina's top environmental official, Regan won praise from supporters for his hard stance in addressing climate change, as well as his work on environmental justice issues, coal ash cleanup and per- and polyfluoroalkyl chemicals, or PFAS, a toxic family of substances found in myriad common household products.

In January, Regan's agency secured an agreement with Duke Energy, the electric utility, to clean up 80 million tons of coal ash — a grayish toxic slurry often stored in thinly lined pits or ponds.

The agency said it was the largest coal ash cleanup program in state history.

Regan's trajectory follows those of former EPA bosses. Before leading EPA during the Clinton years, Carol Browner was in charge of Florida's Department of Environmental Regulation. Lisa Jackson led the New Jersey Department of Environmental Protection before jumping to lead EPA in the early Obama administration years. And Gina McCarthy came from state agencies in New England before succeeding Jackson at EPA.

"There's a pattern there and it's important because so much of what EPA does relies on partnerships of states," Meiburg said.

Ryke Longest, director of the Environmental Law and Policy Clinic at Duke University in North Carolina, said Regan assumed a tough job when he took over.

"His agency's staff levels had been severely cut," Longest said. "The agency's mission had also been truncated with pieces going over to other agencies and micromanagement" by the state legislature.

Regan's predecessors also made it harder for the public to meet with agency staff, he said. "Basically the Department had been put under extreme hierarchy and a decimated budget, which killed morale for public servants working in civil service positions," he said.

Longest credited Regan for his work on coal ash and PFAS cleanup, including from former DuPont facilities.

"So I think he successfully pulled the ox out of the ditch and got it back on the road, as my mother would say," Longest said by email. "I hope that the staff at US EPA and CEQ will provide him the support he

needs to make hard calls to turn around the US EPA," he said, referencing the Council on Environmental Quality, at the White House.

Compared to North Carolina's DEQ, Longest said, "EPA is a much bigger ox, and a much deeper ditch. He will need all the help he can get."

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THE HILL

Biden's EPA gets serious about funding environmental justice

BY DAVID COURSEN, OPINION CONTRIBUTOR — 04/15/21 11:00 AM EDT
THE VIEWS EXPRESSED BY CONTRIBUTORS ARE THEIR OWN AND NOT THE VIEW OF THE HILL

© Getty Images

The Biden administration signaled its commitment to environmental justice in its Jan. 27 executive order on Tackling the Climate Crisis. Now the administration has taken two big steps toward funding that commitment.

First, its American Jobs Plan targets $111 billion to meet the water infrastructure needs of indigenous people, low-income communities and communities of color. Then, last week's Environmental Protection Agency (EPA) budget outline announced a $936 million environmental justice initiative. That would represent a remarkable turnaround for an agency that currently spends just $11.8 million on environmental justice — little more than a rounding error in an agency budget of more than $9 billion.

The next step is for Congress to fully fund these game-changing proposals.

The executive order on climate builds on executive order 12898, President Clinton's foundational 1994 environmental justice order, which highlighted the need for federal agencies to avoid imposing disproportionate environmental burdens on disadvantaged communities. The new order broadens the focus to include distribution of benefits and directs that 40 percent of the benefits of certain federal spending flow to disadvantaged communities.

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The order also mandates a comprehensive federal environmental justice enforcement strategy to address disproportionate burdens on underserved communities and provide them with better environmental information. The budget outline requests $130 million to take these two vital enforcement steps.

Effective enforcement is critical because violations of environmental requirements are so pervasive at all regulated facilities, including the disproportionate share located near disadvantaged communities. One survey found serious violations at a quarter of most types of facilities, with even higher rates — up to 80 percent or more — for large pollution sources with the biggest health effects.

Compounding the problem, a relative handful of facilities do most of the damage. Just 100 facilities — half of one percent of the total — were responsible for an astonishing one-third of America's toxic air pollution in 2014. Too often these "super polluters" operate below the radar, creating sacrifice zones where marginalized indigenous, low-income and communities of color with little power to resist suffer enormous health and environmental burdens.

The outline requests $30 million to get EPA started with strengthening enforcement for overburdened communities.

The climate order also mandates creation of a robust community pollution notification system to monitor and provide real-time data on current environmental pollution to frontline and fenceline communities — where the burdens are heaviest. The budget outline proposes $100 million to begin creating and operating such a system. This significant funding is necessary to upgrade the existing monitoring system, which has a long track record of missing major pollution events and overlooking pollution hot spots.

The climate order calls for disadvantaged communities to receive 40 percent of the benefits from federal spending to address "legacy pollution" by cleaning up Superfund hazardous waste sites and redeveloping brownfield sites that have been cleaned up. The jobs plan provides $5 billion for such cleanup and redevelopment actions, which the proposed budget would supplement with more brownfields funding and $900 million for Superfund cleanups. The benefits from such cleanup and redevelopment projects flow to nearby communities by relieving them from the burdens of hazardous waste exposure or urban blight.

The 40 percent target also applies to clean water infrastructure projects. While the EPA's drinking water and wastewater infrastructure programs have greatly improved our nation's water systems, their benefits have bypassed too many disadvantaged communities. This year's budget plan boosts funding for EPA's existing water infrastructure programs by $620 million, and includes suggestions to use it to improve community water systems, repair septic systems and make broader improvements.

But the $111 billion water infrastructure proposal in the jobs plan would make a far bigger investment in environmental justice. It would direct $45 billion to eliminating lead from the drinking water delivery and service lines and to reducing lead exposure for 400,000 schools and child care facilities. Those aging pipes bring toxic lead into as many as ten million homes, largely in our poorest cities. The plan also provides $56 billion to upgrade and modernize aging drinking water, wastewater and stormwater systems and another $10 billion to address toxic forever chemicals in drinking water and invest in rural water systems.

Bowman to deliver progressive response to Biden's speech to Congress

Senate confirms Janet McCabe as deputy EPA chief

The budget outline also requests $1.8 billion to reduce greenhouse gas emissions and deliver environmental justice, including $130 million for greenhouse gas reduction grants and increased EPA climate change research. The outline also will increase the $90 million diesel emission reduction grant program, which targets deadly transport pollution that is immensely harmful to many poor urban communities. The outline's final piece is money to transform the EPA's civil rights program into an effective tool for advancing environmental justice.

The interlocking pieces of the climate order, the jobs plan and the 2022 EPA budget outline are essential elements of the administration's environmental justice strategy. The administration needs to stand strongly behind them and Congress needs to fully fund them to advance our nation toward environmental justice.

David F. Coursen is a former EPA attorney and a member of the Environmental Protection Network, a nonprofit organization of EPA alumni working to protect the agency's progress toward clean air, water, land and climate protection.

TAGS EPA ENVIRONMENTAL JUSTICE ENVIRONMENTAL JUSTICE COMMUNITIES SAFE DRINKING WATER CLIMATE CHANGE

THE HILL

EPA lost more than 1,500 work first 18 months of Trump administration: report

BY JOHN BOWDEN - 09/08/18 10:44 PM EDT

© Getty Images

The Environmental Protection Agency (EPA) reportedly lost 8 percent of its staff in the first 18 months of President Trump's administration due to high numbers of departing staffers and a low number of new hires.

The Washington Post reported Saturday that nearly 1,600 workers left the EPA during that time, while fewer than 400 were hired. The agency's employment has shrunk to its lowest levels since the Reagan administration, the Post noted.

According to data retrieved by the Post under a Freedom of Information Act request, the EPA has lost as many as 260 scientists, 106 engineers and 185 "environmental protection specialists," numbers which include both longtime veterans of the department and less experienced employees.

The departures have raised fears of a loss of experience at the agency, the Post reported. According to the paper, a number of employees left their posts citing discontent with new policy directions under the Trump administration.

"I felt it was time to leave given the irresponsible, ongoing diminishment of agency resources, which has recklessly endangered our ability to execute our responsibilities as public servants," one former EPA scientist, Ann Williamson, told the Post.

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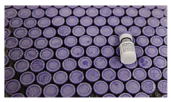

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"I did not want to any longer be any part of this administration's nonsense," she added.

EPA acting Administrator Andrew Wheeler told the Post in a statement that his focus is on recruitment and finding quality staffers for the department — not total staffing levels — noting that many other employees have contracts expiring within the next five years.

"With nearly half of our employees eligible to retire in the next five years, my priority is recruiting and maintaining the right staff, the right people for our mission, rather than total full-time employees," he said.

Trump's former EPA chief Scott Pruitt, who departed the agency amid scandal earlier this year, told The Hill in January that he was proud of staff reductions at the agency, which he called part of the president's plan to shrink government.

"We're proud to report that we're reducing the size of government, protecting taxpayer dollars and staying true to our core mission of protecting the environment," Pruitt said at the time.

TAGS SCOTT PRUITT DONALD TRUMP EPA ANDREW WHEELER ENVIRONMENTAL PROTECTION AGENCY TRUMP ADMINISTRATION

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The New York Times https://www.nytimes.com/2018/07/05/climate/scott-pruitt-epa-trump.html

E.P.A. Chief Scott Pruitt Resigns Under a Cloud of Ethics Scandals

By Coral Davenport, Lisa Friedman and Maggie Haberman

July 5, 2018

Want the latest climate and environment news in your inbox? Sign up here to receive ***Climate Fwd:****, our email newsletter.*

WASHINGTON — Scott Pruitt, the administrator of the Environmental Protection Agency and architect of President Trump's aggressive effort to rewrite the government's rule book on environmental regulations, resigned on Thursday in the face of numerous ethics investigations that doomed his tenure.

Despite Mr. Pruitt's efforts to nurture a close relationship with the president, Mr. Trump himself announced the resignation in a tweet sent from Air Force One. He thanked Mr. Pruitt for an "outstanding job" and said the agency's deputy, Andrew Wheeler, a former coal lobbyist, would take over as the acting administrator on Monday.

Mr. Pruitt in his resignation letter cited "unrelenting attacks on me personally" as one of the reasons for his departure. Mr. Pruitt had been hailed by conservatives for his zealous deregulation, but he could not overcome a spate of questions about his alleged spending abuses, first-class travel and cozy relationships with lobbyists.

Mr. Pruitt also came under fire for enlisting aides to obtain special favors for him and his family, such as reaching out to the chief executive of Chick-fil-A, Dan T. Cathy, with the intent of helping Mr. Pruitt's wife, Marlyn, open a franchise of the restaurant.

The resignation appeared to happen quickly.

On Wednesday, Mr. Pruitt attended two Fourth of July parties, one at the White House and another at the Interior Department. One attendee who spent time with him said he spent the night mingling, shaking hands, watching the fireworks and showing no indication that he planned to step down. His chief of staff, Ryan Jackson, also gave no hint of what was ahead.

An individual close to Mr. Pruitt said the president acted after he found one particular story in recent days embarrassing: a report that Mr. Pruitt had asked Mr. Trump to fire Jeff Sessions, the attorney general, so that Mr. Pruitt could run the Justice Department.

The idea had been discussed privately for months by the president, who occasionally asked advisers if it was a good idea, according to two people familiar with the discussions. But seeing those deliberations being aired publicly, amid a string of other damaging reports, focused Mr. Trump's attention, a person close to the president said. Fresh allegations that Mr. Pruitt had retroactively altered his public schedule, potentially committing a federal crime, had also escalated concerns about him at the White House, according to a White House aide. On Thursday afternoon, around 1:30, Mr. Trump's chief of staff, John F. Kelly, reached out to Mr. Pruitt to tell him the time had come.

Mr. Pruitt, a former Oklahoma attorney general who built his career on lawsuits against the agency he would eventually lead, remained a favorite of Mr. Trump's for the majority of his tenure at the E.P.A. He began the largest regulatory rollback in the agency's history, undoing, delaying or blocking several Obama-era environmental rules. Among them was a suite of historic regulations aimed at mitigating global warming pollution from the United States' vehicles and power plants.

[Mr. Wheeler shares Mr. Pruitt's zeal to dismantle climate change regulations. Read more here.]

Mr. Pruitt also played a lead role in urging Mr. Trump to follow through on his campaign pledge to withdraw the United States from the 2015 Paris climate agreement, despite warnings from some of the president's other senior advisers that the move could damage the United States' credibility in foreign policy. Under the landmark accord, nearly every country had committed to reducing emissions of planet-warming fossil fuel pollution.

In 2017, Mr. Pruitt made headlines for questioning the established science of human-caused climate change, contradicting decades of research by scientific institutions, including his own agency. Although Mr. Pruitt was harshly criticized for the remarks, they did not affect his good standing with a president who has also mocked climate science.

Mr. Trump has repeatedly told associates that Mr. Pruitt has done what he has wanted in terms of cutting regulations, so he has been reluctant to let him go. Mr. Pruitt, for his part, had made himself available to the president as a confidant.

He ingratiated himself in part by offering himself as a sounding board on topics ranging from the North American Free Trade Agreement to to the Russia investigation, and he would join in as the president criticized the attorney general, Mr. Sessions. He often lunched at the White House mess in hopes of running into the president.

But White House advisers, including Mr. Kelly, the president's chief of staff, for months have implored Mr. Trump to get rid of Mr. Pruitt. Ultimately, the president grew disillusioned with Mr. Pruitt after the accusations of impropriety and ethical missteps overshadowed Mr. Pruitt's policy achievements.

In recent days, people who have spoken with Mr. Trump said he sounded exasperated with his E.P.A. administrator's negative headlines. "It's one thing after another with this guy," one person close to Mr. Trump quoted the president as saying.

Mr. Pruitt is the subject of at least 13 federal investigations, and a government watchdog agency concluded that he had broken the law with his purchase of a $43,000 secure telephone booth. He was also under investigation for his 2017 lease of a bedroom in a condominium linked to a Canadian energy company's powerful Washington lobbying firm, and for accusations that he demoted or sidelined E.P.A. employees who questioned his actions.

The former E.P.A. administrator had come under criticism for lavish expenditures on foreign travel, including a trip arranged for him by a lobbyist to Morocco, a country where the E.P.A. has no policy agenda. His domestic travel also came under fire after a former staff member told congressional investigators that his boss often sought to travel to Oklahoma, where Mr. Pruitt owns a home, directing his employees to "find me something to do" there so he could justify charging taxpayers for the expense.

A New York Times report earlier this year detailed Mr. Pruitt's lavish spending and questionable practices in his home state. O n Thursday The Times reported on new questions about whether aides to Mr. Pruitt had deleted sensitive information about his meetings from his public schedule, potentially in violation of the law.

While Democrats have criticized Mr. Pruitt since his nomination, in recent months even conservative Republicans had taken the unusual step of criticizing and questioning his ethics. Representative Trey Gowdy, Republican of South Carolina and the chairman of the House Oversight Committee, has started an investigation into Mr. Pruitt's actions at the E.P.A., the first such Republican-led inquiry into a Trump administration cabinet member.

Joni Ernst and Charles E. Grassley, two Republican senators from Iowa, a farm state with a solid bank of Trump voters, have both publicly criticized Mr. Pruitt. Last month, the conservative National Review, which once championed his appointment, called on Mr. Pruitt to resign. On Tuesday, Laura Ingraham, the conservative talk radio host, tweeted, "Pruitt is the swamp. Drain it."

On May 2, Mr. Gowdy's staff began conducting transcribed, behind-closed-doors interviews with Mr. Pruitt's closest aides. Partial transcripts from one of those interviews revealed that Mr. Pruitt used one of his top aides last year essentially as a personal assistant, having her help him search for an apartment as well as try to procure a used mattress from the Trump International Hotel.

In addition, Mr. Pruitt faced irritation from the White House after The Atlantic magazine reported that Mr. Pruitt's office gave raises to two aides, even though the White House had declined to approve the raises.

The E.P.A. has denied any wrongdoing on Mr. Pruitt's behalf.

As the scandals mounted through the spring, Mr. Pruitt was called to testify before several House and Senate committees. Although they were routine budget hearings, they ended up serving as forums for lawmakers to interrogate Mr. Pruitt about his management practices. Mr. Pruitt, who is deeply religious, spent considerable time in the days before the hearings in prayer, according to a person close to him.

He got through the hearings battered but intact, after deflecting blame for numerous issues onto his staff, particularly his chief of staff, Mr. Jackson, whom he blamed for making controversial decisions such as the illegal purchase of the $43,000 secure telephone booth.

But the tactic of blaming his employees cost him loyalty.

In recent months, nearly a dozen political appointees have quit or been fired from the E.P.A. More recently, many of those staffers have been called to testify to investigators on the House Oversight Committee, which had launched a probe into Mr. Pruitt's expenditures. The results of that investigation were expected to be the subject of a Senate hearing next month.

Inside the E.P.A. on Thursday, as news of Mr. Pruitt's departure spread, some career employees said that the mood was jubilant but quiet given that many people were out of the office around the July 4 holiday. Some employees met for early drinks at Mackey's Public House, a bar near the E.P.A.

It remains unclear how well some aspects of Mr. Pruitt's regulatory rollback agenda, and his effort to undo the environmental work of his predecessors, will stand the test of time. In his haste to cripple government regulation and publicize his success, Mr. Pruitt and his officials have failed to follow important procedures, and courts have already struck down at least six of his rollback efforts.

His removal will deal a blow to his political aspirations. People close to Mr. Pruitt have said that he had been using his prominence in the Trump administration to position himself for a run for state office in Oklahoma. His sights, some said, were set on a possible presidential run in 2024.

Instead, Mr. Pruitt is now the latest in Mr. Trump's purge of top administration officials.

Emily Cochrane contributed reporting.

A version of this article appears in print on , Section A, Page 1 of the New York edition with the headline: Mired in Scandal, Pruitt Is Forced to Exit E.P.A. Post

The New York Times https://nyti.ms/3gvFeak

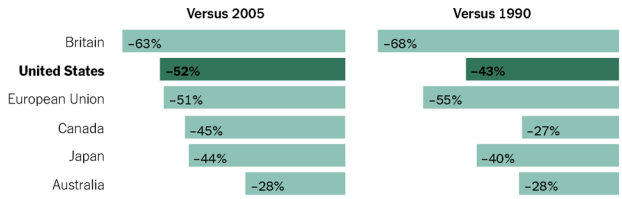
The U.S. Has a New Climate Goal. How Does It Stack Up Globally?

By Brad Plumer and Nadja Popovich Updated April 22, 2021

The United States officially has a new goal for fighting climate change over the next decade. So how ambitious is it?

President Biden announced Thursday that America would aim to cut its greenhouse gas emissions 50 percent to 52 percent below 2005 levels by 2030. That's one of the more aggressive near-term targets among wealthy industrialized nations, although the cuts are arguably not quite as large as what the European Union and Britain have already promised.

How Pledges to Cut Emissions Compare



Source: Rhodium Group ▪ Charts reflect high end of emissions reduction pledges.

Comparing national pledges to cut emissions can be surprisingly tricky — a lot depends on the year you start counting from. The United States has decided to measure its reductions from 2005, which is roughly when the nation's fossil fuel emissions reached a peak. But European countries tend to measure their reductions from 1990, when emissions began falling across the continent as a result of early climate policies and the collapse of polluting Communist economies in the East.

The later baseline makes the United States target look a bit better, because it omits a period when emissions were rising. An earlier baseline makes Europe look more ambitious, since it has been cutting for longer.

Mr. Biden unveiled the pledge at a White House climate summit for world leaders, declaring that the United States is ready to reclaim a leadership role on climate change. Japan also announced it would strengthen its

climate targets, aiming for what translates to a 44 percent cut below 2005 levels by 2030. Canada also updated its climate goals, committing to a 40 percent to 45 percent cut below 2005 levels by 2030.

Ultimately, however, there's one climate metric that matters most: How quickly the entire world can get to zero emissions and halt the warming of the planet.

To avoid many of the most catastrophic risks of climate change, such the collapse of polar ice sheets or widespread crop failures, scientists have said that the world likely needs to zero out emissions from fossil fuels and deforestation by around mid-century. "If the ultimate goal is zero emissions, then the metric we really care about is how quickly countries can get to zero," said Kate Larsen, a director at Rhodium Group, an energy research and consulting firm.

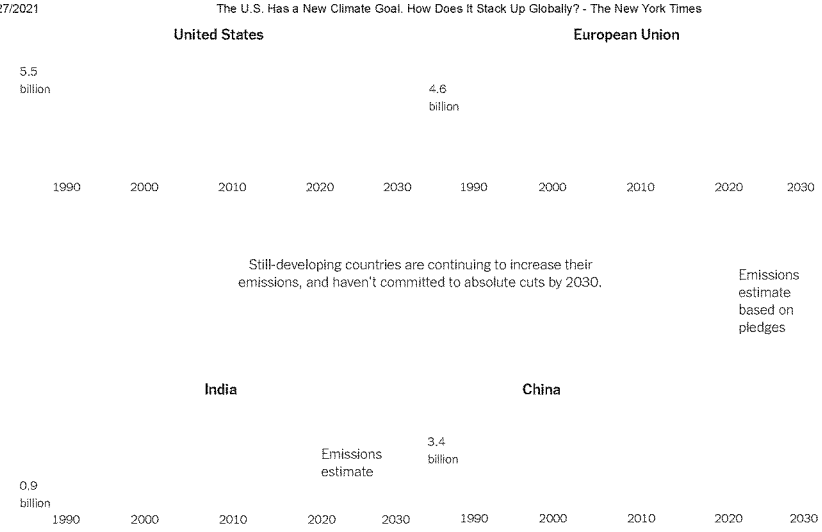
On that score, the world is still falling far short.

While the United States and the European Union are both now vowing to get roughly halfway to zero by 2030 — on the way to net zero emissions by 2050 — they account for only one-quarter of global greenhouse gas emissions. But many lower-income countries, including China and India, still expect their emissions to either plateau or keep rising over the next decade.

Trajectories for the World's Largest Emitters

The United States was still increasing emissions until the mid-2000s, while Europe took earlier action.

In metric tons CO_2



Source: Rhodium Group

China, the world's largest emitter of greenhouse gases, has pledged that its emissions will peak by around 2030. From that point, the country will then aim to get down to net zero emissions by 2060. China has also laid out some concrete targets, such as getting one-quarter of its electricity from low-carbon sources like wind, solar or nuclear power; planting vast new forests; and curbing the use of hydrofluorocarbons, a powerful greenhouse gas used as a refrigerant.

If all those targets are met, an analysis by the Rhodium Group found, China's emissions could level off close to current levels by the end of the decade, although the exact numbers depend on how rapidly the country's economy grows.

But China is not yet committing to specific cuts before 2030. China's argument is that it was slower to industrialize than the United States and Europe, and therefore needs more time to pivot away from fossil fuels like coal. "When it comes to climate change response, China is at a different stage than the U.S., Western nations and other developed countries." Le Yucheng, China's vice foreign minister, said last week.

India, for its part, has not yet formally set a date for when its emissions will peak, though it has announced goals for increasing the use of cleaner energy sources like solar power and slowing its growth in fossil-fuel consumption. Officials there point out that India is still much poorer than the United States or Europe, and it is unfair to hold them to the same standard.

The U.S. Still Had the Highest Per-person Emissions in 2019

Sources: Rhodium Group, World Bank

Indeed, looking at emissions per person tells a different story about which country is doing the most. Currently, the United States uses far more fossil fuels per person than almost any other country in the world, although China is quickly narrowing the gap.

If every country were to meet its stated climate goals, America's per capita emissions would decline and converge with China's by 2030, the Rhodium Group estimated. But both countries' per capita emissions would still be twice that of Europe's and nearly four times that of India's.

Partly for that reason, some environmentalists have argued that the United States should have picked an even more ambitious target for reducing emissions. Doing so would not only make up for decades of being by far the world's largest emitter, they argue, but would also give lower-income countries like India more time to transition off fossil fuels. One recent report by a range of civil society groups urged the United States to commit to a 70 percent cut by 2030, along with vast new funding for clean-energy projects in the developing world.

"If you're asking whether the U.S. target is fair and ambitious, the right yardstick isn't what will pass muster with the Senate," said Sivan Kartha, a senior scientist at the Stockholm Environment Institute and a co-author of the report. "The question is what should the United States do given its capacity to act and its historical responsibility for causing the problem?"

Many Republicans in Congress have argued that the Biden administration is acting too aggressively on climate change when countries like China and India have yet to commit to absolute emissions cuts. Senator John Barrasso, Republican of Wyoming, said that the president was "unilaterally committing America to a drastic and damaging emissions pledge" that would punish the U.S. economy while "America's adversaries like China and Russia continue to increase emissions at will."

The Biden administration's calculus is that it should set a target that is both challenging to meet but also politically plausible. By doing so, officials say, they can persuade other countries to do more — both through diplomatic pressure and by driving down the cost of new low-carbon technologies, such as electric vehicles or hydrogen fuels, to make it easier for other countries to act.

It remains to be seen if the United States can pull that off.

The Biden administration invited more than 40 world leaders to this week's climate summit with the hope that other countries might announce fresh commitments of their own. Mr. Biden has long vowed to transform the United States into a global leader on climate change, after the Trump administration had largely dismissed the issue for four years.

So far, the results have been mixed. Japan and Canada both agreed to strengthen their 2030 targets. The British government said Tuesday that it would step up action with a new target, cutting emissions 78 percent below 1990 levels by 2035. But other major emitters such as China, India and Russia have yet to offer significant new pledges.

The Biden administration also faces serious questions about whether it can actually meet its 2030 climate target, which unlike the pledges from the European Union or Britain, is not enshrined into law. After all, lofty goals on paper will achieve little unless they're backed up by concrete action.

One recent study estimated that America's greenhouse gas emissions have already fallen 21.5 percent between 2005 and 2020. Much of that was the result of electric utilities retiring their dirtiest coal plants in favor of cleaner and cheaper natural gas, wind and solar power. An additional one-third of cuts resulted from the coronavirus pandemic, because business activity slumped and people drove less. However, emissions are expected to rebound this year as the economy rumbles back to life.

To get at least a 50 percent cut by 2030, a variety of studies have found, the United States would need to adopt sweeping new policies and slash emissions each year at an unprecedented rate. Possible strategies include

requiring utilities to install vastly more wind and solar power, persuading Americans to buy many more electric cars, and forcing oil and gas companies to slash emissions of methane, a potent heat-trapping gas. States like California and New York could help, too, by following through on their plans to clean up their power plants and vehicle fleets.

Mr. Biden has already proposed a number of new climate measures. His big infrastructure proposal, estimated at between $3 trillion and $4 trillion, includes tax incentives for clean energy and electric vehicles. Separately, the Environmental Protection Agency is looking at enacting stricter regulations for tailpipe pollution from cars and trucks and for methane emissions.

But none of those measures have passed into law yet. And they face an uncertain fate in Congress and the courts.

"There are a number of plausible pathways to hit that target, but it's frankly going to be challenging," said Nathan Hultman, director of University of Maryland's Center on Global Sustainability who has modeled what a 50 percent cut would require. "We won't be able to sit back and hope that market forces alone will do the job."

Many countries face similar questions.

Canada, for instance, has pledged to cut emissions up to 45 percent below 2005 levels by 2030. Its emissions have fallen just 1 percent, but Prime Minister Justin Trudeau said that the country's adoption of a hefty new carbon tax would help meet the new targets. In Britain, environmental groups have warned that the nation's ambitious promises have yet to be backed up by rigorous new policies.

There's also the biggest uncertainty of all: Mr. Biden's first term ends in 2024. What happens if he is succeeded by a president who abandons his climate targets, much as President Trump dismantled President Obama's regulations on greenhouse gas emissions?

In the European Union and Britain, there's a broader political consensus around climate policy that doesn't change too drastically when different parties take power. But in nations like Australia, Canada or especially the United States, rival political parties often have sharply divergent views on how quickly they should cut emissions — or even whether it's desirable to cut emissions at all.

"In countries where a change in government can derail the whole thing," said Oliver Geden, a senior fellow at the German Institute for International and Security Affairs, "it's a lot harder to be sure that these goals are here to stay."

Notes: Charts show the carbon dioxide equivalent of net greenhouse gas emissions, including emissions and sinks from land use and forestry. Rhodium Group's estimates of emissions data for each country from 1990 to 2019 includes all major greenhouse gases, consistent with national reporting to the United Nations. Emissions from international aviation and shipping are excluded from national figures.

Emissions trajectory charts for the United States and the European Union reflect pledged emissions cuts by 2030. For China and India, future emissions trajectories assume that both countries fulfill all of their publicly stated climate pledges and phase down hydrofluorocarbon gases in line with their commitments under the Montreal Protocol. The high end projections for China and India assume slightly faster annual economic growth than projected by the International Energy Agency through 2030, the low end assumes slightly slower growth.

Correction: April 22, 2021
An earlier version of this article misidentified the current prime minister of Canada. He is Justin Trudeau, not Pierre Trudeau.

The Washington Post
Democracy Dies in Darkness

Biden budget seeks to flip script on Trump administration's spending priorities

The White House wants more money for all the programs Trump had sought to slash.

By **Rachel Siegel**

April 9, 2021 at 11:20 a.m. EDT

President Biden's first budget request to Congress includes $1.5 trillion in federal spending that turbocharges funding for education, health and environmental protections — flipping the script on the very programs the Trump administration long ridiculed and sought to slash.

The split is also laid bare in defense spending, which ramped up during the Trump years but would stay essentially flat under Biden's pitch.

The White House proposal released Friday now goes to Congress, which ultimately holds the purse strings. Democrats hold narrow majorities in the House and Senate and are likely to rely on Republicans to get the budget through, especially as Democrats vie for a massive jobs and infrastructure plan on top of Biden's recent coronavirus stimulus bill.

But no matter how Congress recalibrates the request, Biden's initial swing stands in stark contrast to Trump's spending goals. Trump's budget proposals were often ignored by Congress, but they did serve as a marker of his priorities. He mostly sought to slash programs he alleged were examples of bloated government waste. Biden's budget frames the government in a much different light.

His proposal, for example, includes almost $103 billion for the Education Department, a massive 41 percent increase over the 2021 enacted level.

The White House proposal would bolster the Title I program, which serves high-poverty schools, doubling funding. It falls short of Biden's campaign promise to triple funding, but would still easily represent the largest increase in the program's history and comes on top of a huge infusion of funds to these schools through the rescue act. The plan also targets students' physical and mental well-being by increasing the federal support for counselors, nurses and mental health professionals in schools. And the request would increase funding for special education and related services for students with disabilities, taking a small step toward Biden's campaign goal of fully funding the longtime unfulfilled federal commitment for special education.

For higher education, Biden's proposal invests an additional $3 billion in Pell Grants, allowing an increase of $400 to the maximum grant, now set at $6,345. That falls well short of his promise to double Pell Grants, though more funding could be coming when the White House releases its complete budget plan. He called for dreamers, undocumented young people who were brought to the United States as children, to become eligible for Pell Grants, a policy change

Congress would need to endorse. The proposal also seeks to boost funding for historically Black colleges and universities, tribally controlled colleges and universities and other minority-serving institutions.

By comparison, Trump's budget proposal for 2021 sought to cut education funding by $5.6 billion, or roughly 8 percent. Trump's final plan while in office sought steep cuts to the student loan program intended to slash popular initiatives like a loan forgiveness program for students who take public service jobs, and subsidized lending for low-income students. In terms of spending increases, Trump's proposal put a new $5 billion tax credit to reward donors who contribute to private school scholarships.

On health-care spending, Biden's proposal would ramp up funding for the Department of Health and Human Services to $131.7 billion, a 23.5 percent increase from the 2021 enacted level.

That would include $8.7 billion for the Centers for Disease Control and Prevention, up $1.6 billion over the 2021 enacted level and the largest budget authority increase for the CDC in nearly 20 years. The request also includes $905 million for the Strategic National Stockpile to replenish critical medical supplies and other needs amid the pandemic.

Beyond coronavirus, the proposal would put $10.7 billion to combat the opioid crisis, and $670 million to fight the country's HIV/AIDS epidemic. It also increases appropriations for mental health services and block grants and expands suicide-prevention activities. The proposal also spans a number of other health-based initiatives, including addressing racial disparities in health care, reducing the maternal mortality rate and increasing funding for domestic violence hotlines and medical support.

Trump's 2021 budget proposal sought to cut HHS discretionary spending by 9 percent. The proposal sought to eliminate Community Development Block Grants, low-income energy assistance and certain training programs for health professionals — efforts which had long been part of a conservative push.

Under Trump's proposal in February 2020, the budget for the CDC would have been reduced by almost 16 percent. At the time, HHS officials proposed refocusing the CDC on its core mission of preventing and controlling infectious diseases and other public health crises, such as opioid addiction, while cutting funding for non-infectious-disease activities.

Adding to Biden's broader push for a greener economic and climate policy, the administration's budget proposal would hike funding for the Environmental Protection Agency by 21.3 percent from the 2021 enacted level. The proposal spans efforts to restaff the EPA — which lost nearly 1,000 workers over the past four years — and investments to reduce greenhouse gas emissions.

Building on Biden's jobs and infrastructure proposal, the budget request includes funding for community water systems, repairs for septic systems and cleaning up contaminated land.

In contrast, Trump sought deep cuts at the EPA and put forward a 2021 budget that would decrease funding by 26 percent from 2020 enacted levels. The White House zeroed in on what it called "50 wasteful programs that are outside of EPA's core missions or duplicative of other efforts" as part of a widespread push to reverse many of the environmental protections put in place during the Obama administration.

And in another split, the Biden administration is seeking to increase funding for the Department of Commerce by 28 percent from the 2021 enacted level. Trump's 2021 proposal sought to slash Commerce's budget by 37 percent — 10 percent more than any other department — largely due to the decrease in spending on the U.S. Census.

The Trump years were also marked by dramatic attempts to increase military spending. Trump's proposed 2021

The Trump years were also marked by dramatic attempts to increase military spending. Trump's proposed 2021 budget gave a roughly 13 percent boost to the Department of Veterans Affairs. It also sought to increase overall spending to the Department of Homeland Security by 3.2 percent and would have increased NASA's budget by $2.7 billion, putting $700 million to support lunar activities.

Now, Biden is proposing a 1.7 percent increase in funding for national defense programs — much smaller than the administration's other pushes for education, climate and health. Funding for DHS would stay roughly equal to the 2021 enacted level. Investments in the Department of Veterans Affairs would go up 8.2 percent, and funding for NASA 6.3 percent.

Laura Meckler contributed to this report.

Staff exodus hits EPA under Trump: 'I could do better work to protect the environment outside'

By BRADY DENNIS and JULIET EILPERIN AND ANDREW BA TRAN
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Christopher Zarba retired in February after serving on the EPA's Scientific Advisory Board. He disagreed with plans to overhaul the board's membership. (Doug Kapustin / For The Washington Post)

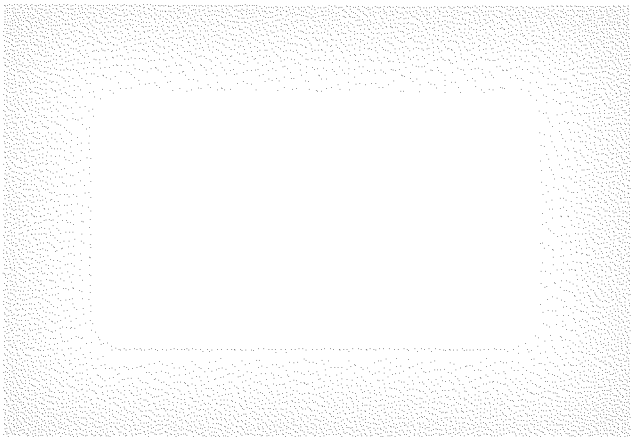
WASHINGTON — On the campaign trail, Donald Trump vowed to dismantle the Environmental Protection Agency "in almost every form. We're going to have little tidbits left, but we're going to take a tremendous amount out."

As president, he is making headway on that promise.

During the first 18 months of the Trump administration, records show, nearly 1,600 workers left the EPA, while fewer than 400 were hired. The exodus has shrunk the agency's workforce by 8 percent, to levels not seen since the Reagan administration. The trend has continued even after a major round of buyouts last year and despite the fact that the EPA's budget has remained stable.

Those who have resigned or retired include some of the agency's most experienced veterans, as well as young environmental experts who traditionally would have replaced them — stirring fears about brain drain at the EPA. The sheer number of departures also has prompted concerns over what sort of work is falling by the wayside, from enforcement investigations to environmental research.

According to data released under the Freedom of Information Act and analyzed by The Washington Post, at least 260 scientists, 185 "environmental protection specialists" and 106 engineers are gone.



"I felt it was time to leave given the irresponsible, ongoing diminishment of agency resources, which has recklessly endangered our ability to execute our responsibilities as public servants," said Ann Williamson, a scientist and longtime supervisor in the EPA's Region 10 Seattle office.

She left in March after 33 years at the agency, exasperated by having to plan how her office would implement President Trump's proposed cuts and weary of what she viewed as the administration's refusal to make policy decisions based on evidence. "I did not want to any longer be any part of this administration's nonsense," she said.

In a statement Friday, Acting Administrator Andrew Wheeler said he was focused on right-sizing the EPA, which Republicans have argued overreached under President Barack Obama, burdening industry with regulations such as those focused on climate change.

Congress has so far maintained the EPA's budget at just more than $8 billion, and while current proposals could shrink that amount, any cuts are likely to be modest.

"The Trump administration comes in and goes way, way beyond what the budget requires," said Rep. David Price, D-N.C., a senior member of the House Appropriations Committee and whose district is home to a major EPA research center. Price said multiple constituents have told him that working at the EPA has become "intolerable" after seeing their findings sidelined.

"It is profoundly demoralizing, and I think, profoundly damaging in terms of the agency's mission," he said.

The EPA is not alone in shedding personnel under Trump, despite the fact that Congress passed a $1.3 trillion budget bill in March that boosted both military and domestic spending.

The State Department's total number of permanent employees, for instance, fell 6.4 percent between Trump's inauguration and March 2018, according to federal records, while the Education Department declined 9.4 percent during that time.

Part of the drop stems from a government-wide hiring freeze Trump imposed after his inauguration, which lasted nearly three months. The president has continued to press for a leaner federal payroll, asking Congress recently to withhold pay raises for federal workers in 2019.

In a few instances, Trump's deputies are trying to fill the widespread vacancies in their department's ranks. Secretary of State Mike Pompeo recently began trying to staff the many senior positions that remained empty under his predecessor, Rex Tillerson. Meanwhile, Veterans Affairs is eager to hire doctors, nurses and other medical professionals to fill thousands of vacancies.

But at the EPA, it is largely a case of career staff members headed for the exits. Hundreds of employees accepted buyouts last summer, and records show that nearly a quarter of the agency's remaining 13,758 employees are now eligible to retire. At its peak in the late 1990s, the EPA employed more than 18,000 people.

Christopher Zarba, who retired in February after serving as director of the EPA's Scientific Advisory Board, disagreed with former administrator Scott Pruitt's decision last year to overhaul the board's membership. Zarba, a 38-year EPA veteran, said that for many staff members, a belief in the agency's mission had compensated for less-than-ideal working conditions.

"That is the crazy glue that holds the place together, the idea, 'This is important. We're making a difference,' " he said. "And when that crazy glue begins to fall apart, things change."

shelved a project she was leading that ai
climate change and other environmental challenges.

"It's really awful to feel like you don't have any role to play, that there's not any interest in the work you're doing," said Smith, 62. "My feeling was I could do better work to protect the environment outside the EPA."

Troy Hottle, 32, arrived at the EPA in early 2016 as a research fellow after getting his doctorate in sustainable engineering at Arizona State University. He expected to forge a career there, as others like him had historically done.

"I really felt good about what I was doing and who I was working with," Hottle said.

But a year and a half into his time at the EPA, the future hiring prospects within the Office of Research and Development seemed uncertain at best. The career path he had "spent half a lifetime" pursuing, he said, no longer looked so appealing.

Last September, when he got a job offer from a national environmental consulting firm, he decided to make the leap.

After his arrival, Pruitt quickly gained a reputation for excluding career officials from key decisions and showing little regard for the agency's own research. He also took the president's desire to scale back the EPA to heart, repeatedly boasting about how a buyout and early retirement push last year reduced the agency workforce.

Other conservatives also have cheered the whittling down of EPA's size and reach as appropriate and overdue.

"It doesn't take a bigger bureaucracy to clean our environment," Rep. Ken Calvert, R-Calif., who chairs the House subcommittee overseeing the EPA's budget, said in a statement. "A lean and efficient workforce at the EPA is a win for taxpayers and

EPA officials last year launched a reorganization aimed at streamlining the agency, and Wheeler has struck a more measured tone as he has pursued it. A former EPA staff member himself, he praised career employees in a speech after his appointment, saying his "instincts" would be to defend their work and sympathizing about the stress that comes with the changes the agency is undergoing.

On Thursday, he sent an agencywide email announcing that regional offices would be redesigned to mirror the structure at headquarters.

As the departures continue, some EPA workers have voiced worries that the

Dan Costa, 70, joined the EPA 34 years ago as a staff scientist, rising through the ranks to direct its national air, climate and energy research program in 2011. He stepped down from that post in January, and he said he spent part of the last year counseling younger researchers who saw no possibility of replicating his career path.

"I had young people come into my office, close the door and say, 'What should I do? Should I be looking for a job somewhere else?' " he said. He said he advised one young man to "test the waters" given the current regime. "These people are like termites, gnawing at the foundation."

Multiple current and former employees also say that the exodus at the EPA has left important work falling through the cracks. In Chicago, for instance, a civil investigator responsible for probing who is responsible for Superfund sites left earlier this year and has yet to be replaced, said Mike Mikulka, president of the local union that represents EPA employees.

"You can talk all you want, but your actions speak far louder," he said, noting that Pruitt had held up Superfund as a top priority during his tenure. "What's happening is that the lowest priority work just doesn't get done. And some of that work is really critical."

One of the EPA divisions hardest hit by staff cuts is the Office of Enforcement and Compliance Assurance, whose numbers dipped 15.7 percent between January 2017 and August 2018. Several experts said that any cuts to that division have a major impact because the vast majority of its budget comes from personnel costs rather than grants or other expenditures.

Granta Nakayama, who headed the office from 2005 to 2009, said that it couldn't sustain that deep a staffing cut without curtailing some of its operations.