

S. HRG. 118–75

WHO PAYS THE PRICE: THE REAL COST OF FOSSIL FUELS

HEARING BEFORE THE COMMITTEE ON THE BUDGET UNITED STATES SENATE ONE HUNDRED EIGHTEENTH CONGRESS FIRST SESSION

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WHO PAYS THE PRICE: THE REAL COST OF FOSSIL FUELS

WEDNESDAY, MAY 3, 2023

COMMITTEE ON THE BUDGET,
U.S. SENATE,
Washington, DC.

The hearing was convened, pursuant to notice, at 10:04 a.m., in the Dirksen Senate Office Building, Hon. Sheldon Whitehouse, Chairman of the Committee, presiding.

Present: Senators Whitehouse, Kaine, Luján, Grassley, Johnson, Marshall, Braun, and R. Scott.

Also present: Democratic staff: Dan Dudis, Majority Staff Director; Matthew Bolden, Climate Policy Advisor.

Republican staff: Chris Conlin, Deputy Staff Director; Krisann Pearce, General Counsel; Nick Wyatt, Professional Staff Member; Jordan Pakula, Professional Staff Member.

Witnesses:

Dr. Ted Gayer, President, Niskanen Center

Dr. Nicole Deziel, Associate Professor of Epidemiology, Yale School of Public Health

Ms. Diana Furchtgott-Roth, Director of the Center for Energy, Climate, and Environment, The Heritage Foundation

OPENING STATEMENT OF CHAIRMAN WHITEHOUSE¹

Chairman WHITEHOUSE. Let me call the hearing to order and express my appreciation to the witnesses for their patience. Senator Grassley and I and other members have multiple committee hearings taking place during the day and where you stand in the queue in those other committees depends on whether you have checked in in person. Senator Grassley and I are both checking in in person in finance, and I thank you all for your patience.

We are going to start with opening remarks by me and Senator Grassley and then I will introduce the witnesses. We will proceed with five minute statements and then go on to questions and answers.

I want to welcome everyone to what is our seventh committee hearing on the economic and budgetary perils of our overdependence on fossil fuels. We have heard repeated testimony from non-partisan, knowledgeable industry leaders about the threat climate change poses to entire sectors of our economy, healthcare, insurance, coastal economies, wildfire areas and, of course, the carbon bubble, leaving fossil fuel assets stranded. So in light of those

¹Prepared statement of Chairman Whitehouse appears in the appendix on page 30.

threats and warnings, what are we, the federal government doing, to protect the American people? Well, actually what we are doing is subsidizing the danger. As we will hear today, the United States subsidizes the fossil fuel industry with taxpayer dollars. It is not just the U.S. according to the International Energy Agency. The fossil fuel handouts hit a global high of \$1 trillion in 2022, the same year that big oil pulled in a record \$4 trillion of income. You see the dependence on public funds.

In the United States, by some estimates, taxpayers pay about \$20 billion every year to the fossil fuel industry. What do we get for that? Economists generally agree, not much. To quote conservative economist Gib Metcalf, these subsidies offer, and I quote, "little, if any, benefit in the form of oil patch jobs, lower prices at the pump or increased energy security for the country." The cash subsidy to big oil is both big and wrong.

But the really big subsidy is the license to pollute for free. The IMF called this global free pass an implicit fossil fuel subsidy. Economists call it an unpriced externality. Behind these benign sounding phrases occurs a lot of harm.

Start with the harmful effects of local air pollution. Researchers from Harvard found pollutants from oil and gas combustion were responsible for 8.7 million premature deaths annually. The increased mortality rates from heat and air pollution we heard about at last week's hearing. Then growing costs from intensifying disasters, wildfires, floods, droughts, which according to the United States Office of Management and Budget (OMB) could cost the federal budget \$2 trillion annually and reduce U.S. Gross Domestic Product (GDP) 3 to 10 percent by the end of the century.

You tally up the harms and the International Monetary Fund estimates that the penalty is a \$5.4 trillion annual subsidy worldwide. In the United States, it is a \$646 billion subsidy every single year. Worse, this almost certainly undercounts the true costs. The London School of Economics reports that studies often underestimate the harm of climate dangers by failing to account for, as we've heard in these hearings, how hazards can cascade across ecological and economic systems.

The cascades can cause irreparable damage to human well-being, to ecosystems and to the U.S. economy. These are the systemic risks that we have been hearing about in these hearings. And as we'll hear from one of our witnesses today, the very act of extracting these dirty fuels has terrible consequences for human health, especially for children. From high rates of birth defects to childhood leukemia, there is ample evidence that communities around oil and gas extraction sites pay an especially high price.

It is textbook economics that the price of a product should reflect its true cost. The fossil fuel industry violates this rule of market economies. It does so by spending billions of dollars on disinformation, false doubt, climate obstruction and political dark money. And why not, to protect one of the most lucrative subsidies in human history? This, ladies and gentlemen, is why we can't have nice things like clean air, safe coral reefs, secure coast lines and affordable clean energy.

Over in the House, MAGA extremists are doubling down on polluter handouts to their big donors with their Default on America

Act that put the American taxpayer on the hook for climate disaster. That bill is not about debts or deficits.

It is dirty work for an industry that controls one of the main political parties in this country.

Oil and gas extraction represents only about 5 percent of GDP. Farming, manufacturing, food and beverage, insurance, finance, restaurants, retail, housing, healthcare, all represent a larger share of GDP. Clean energy now accounts for more employment than the fossil fuel industry. But for political influence, to protect those massive subsidies, nothing compares to fossil fuel.

It is a fundamental principle of democracy that everyone should get an equal say. But with fossil fuel, the rich and the powerful hoard all the benefits for themselves and leave everyone else, often the most vulnerable Americans, to pay the price.

Senator Grassley.

OPENING STATEMENT OF SENATOR GRASSLEY²

Senator GRASSLEY. Last week's hearing on climate change and public health was another missed opportunity to discuss our nation's ailing fiscal health. That same day, House Republicans passed legislation to reign in excessive government spending, lift the debt ceiling and impose meaningful fiscal controls. Meanwhile, Senate Democrats haven't lifted a single finger.

Now instead of working together to write a responsible budget, we are here discussing an alleged scheme involving fossil fuel overlords. Rather than attacking important American businesses that employ tens of thousands of Americans, we should work together to reduce an unsustainable national debt.

Reaching a consensus will require us to respectfully listen to opinions of experts whose views may differ from our own. No one learns anything sitting in an echo chamber. This is one reason why I have invited witnesses with a variety of views during this series of climate change hearings.

Sometimes I have discussed with a witness that I invited on this or that subject, but sometimes I have disagreed with witnesses I have invited on this or that, but I value their opinions. Today is no different. Ms. Furchtgott-Roth and I don't see eye to eye on all energy matters, particularly when it comes to renewable fuels and wind. However, we do agree oil and gas are critical to lowering energy costs, protecting our national security and reducing CO2 emissions. We also agree that President Biden's war on fossil fuels has been disastrous for the economy and terrible for consumers.

I believe in all-of-the-above energy strategies, oil, gas, biofuel, wind. We need them, all for national security and for economic success. President Biden, on the other hand, believes in all of his preferred and none-of-the-rest strategy.

It is kind of simple in this town, people say they are all of the above. Well, half of them are for none of the above, but everything below. And the other half are for everything above but nothing below the ground. This sort of one size fits all to solving this problem just doesn't make sense.

²Prepared statement of Senator Grassley appears in the appendix on page 32.

I have been saying for 30 years, a long time before climate change was much of a debate, that we had four goals that we had to have for energy policy, one, fossil fuels, number two, all of the alternative energy you can think of and number three, conservation, both government-imposed and personally imposed, and four, nuclear. It seems to me that that is still a policy we are going to have for the next 25 years except for the unrealistic views that we can get everything by wind tomorrow.

Poor policy decisions have consequences. And as a result, we have seen energy prices rise substantially across the board. This is why the two leading topics of concern that I have heard from Iowans during the Biden Administration have been inflation and the price of gasoline. The President can deflect blame all he wants, but the rise in the price of gasoline has been a direct consequence of his administration's energy policies.

Candidate Biden vowed to end fossil fuels during his campaign. On his first day in office, he decided to shut down the Keystone pipeline, stifling our ongoing energy independence and killing thousands of jobs. Also in January 2021, he issued an executive order pausing new oil and gas leases on public lands and federal waters.

And now he complains because Saudi Arabia is cutting down on the pumping of oil by \$1 million a day and the price going up, and we reduced the national strategic reserve to the lowest level in 40 years. It just doesn't make sense that we would stop jobs in this country to increase more jobs in Saudi Arabia and import the oil here and probably dirtier oil than we produce in this country. A barrage of his destructive environmental regulations followed, which continue to prevent the construction of much needed fossil fuel infrastructure.

Last month, President Biden issued his first veto to uphold his 401(k) investment rule. The rule will even hurt everyday Americans' investment just to further liberal Environmental Social Corporate Governance, or ESG as you know it, whereas the federal law requires under the Employee Retirement Income Security Act of 1974 (ERISA) that the fiduciary has the responsibility to make sure that you get the most return on your money. That's what the law says. And this administration, through ESG, is violating that law.

And just a few weeks later, President Biden's Environmental Protection Agency (EPA) announced his plan to mandate two-thirds of all new vehicles be electric by 2032. These are the same Electric Vehicles (EVs) most Americans can't afford. The same EVs that they say in California last year don't plug in during the heavy use of utilities because you may not get the electricity to charge your EV. But Democrats want to continue subsidizing these as part of their misnamed Inflation Reduction Act, which by now the Congressional Budget Office (CBO) has proven to not reduce inflation but actually enhance inflation. And that's that green energy program that is within that bill that has a price tag that seems to be ballooning way above what CBO said it was going to be.

And to prove that, we have the Joint Committee on Taxation telling us its tax subsidies will cost \$300 billion more than originally advertised, and its costs could rise further once we receive updated scores of EV subsidies.

The average price of an electric vehicle according to Kelley Blue Book is \$65,000, roughly the equivalent of Iowa's median household income. But even if half of the Americans could afford an EV, which they can't, an even bigger problem exists. We have neither the load capacity nor the materials to achieve President Biden's energy overhaul.

Large swaths of the U.S. electric grid are at risk for shortfalls this summer. Grid reliability is a significant concern already let alone the concerns over the grid handling load of President Biden's electric vehicle fantasy. Moreover, we all know that the Communist Party of China has a monopoly on critical mineral mining and refining required to build EV batteries. They are forcing Uyghurs into slavery to bolster their supply chains. That is all being supported by this administration. Meanwhile, environmentalists won't allow us to permit mining projects here in the United States.

And think of inconsistency between the human rights policies of this administration, which I have no disagreement with, but letting the Uyghurs, with forced labor, to produce some of the stuff that we are going to use in our electric vehicle cars or look at what, I think it is cobalt or something else that we get from the Congo Republic, that child labor is being used to produce. And this administration and the Republicans in this Congress are against using child labor for anything as far as that is concerned.

So not only is this administration pushing policies that drive up the price of gasoline, but their policies would make us even more dependent on a supply chain that runs directly through China. Thank you, Mr. Chairman.

Chairman WHITEHOUSE. Thank you, Senator Grassley. Let me just take a moment and salute you for your long-term leadership on conservation issues on alternative fuels, particularly ethanol, and on wind power which is important in your home state.

Mr. GRASSLEY. I am the father of the Wind Energy Tax Credit.

Chairman WHITEHOUSE. There you go exactly and have defended it very strongly. And we worked together.

Mr. GRASSLEY. We get 60 percent of our electricity from wind. And in 4 years, we will get about 80 percent.

Chairman WHITEHOUSE. And for what it is worth, my Chevy Bolt is very affordable. Let me turn first—let me introduce the witnesses. We have Ted Gayer here. He is the President of the Niskanen Center. He was formerly the Executive Vice President of the Brookings Institute. He served as Deputy Assistant Secretary for Microeconomic Analysis at the Department of Treasury and as a senior economist on the Council of Economic Advisors under President George W. Bush. We welcome his testimony.

Next, we have Dr. Nicole Deziel, who is an Associate Professor at the Yale School of Public Health. She is an expert on the human health impacts of oil and gas development. Her work has contributed to the field's understanding of the underlying exposure mechanisms, the unequal distribution of the health impacts, and the policies for mitigating these dangerous hazards. We look forward to her testimony.

Finally, Ms. Diana Furchtgott-Roth is the director of the Center for Energy, Climate and the Environment at the Heritage Foundation and an Adjunct Professor at George Washington University.

(GW). She was formerly a senior fellow at the Manhattan Institute and the Hudson Institute as well as a fellow at the American Enterprise Institute.

She served in the White House under Presidents Reagan, George H.W. Bush and W. Bush and as Deputy Assistant Secretary for Research and Technology at the Department of Transportation as well as Acting Assistant Secretary for Economic Policy of Treasury during the Trump Administration.

Dr. Gayer, welcome. You have five minutes to deliver your statement.

**STATEMENT OF DR. TED GAYER, PRESIDENT, NISKANEN
CENTER³**

Dr. GAYER. Chairman Whitehouse, Ranking Member Grassley and members of the committee, thank you for inviting me here today. My name is Ted Gayer, and I am the President of the Niskanen Center. As Senator Whitehouse said, I previously served as Deputy Assistant Secretary at the Department of Treasury and a senior economist at the Council of Economic Advisors, both in the George W. Bush Administration.

I want to address three points today. First, instead of providing subsidies to fossil fuels, our Tax Code should promote market incentives that factor in the external costs of energies.

Second, the size of the existing fossil fuel subsidies depends on various factors, such as whether one is focusing on their overall size or their size compared to subsidies granted to other industries, as well as whether, as Senator Whitehouse mentioned, when it counts for the external costs of fossil fuels.

And third, eliminating fossil fuels would have a minimal impact on both fossil fuel production and prices.

Historically, federal energy tax policies have at various times sought to boost domestic energy production, generate tax revenue and promote environmental quality. These goals are often in conflict, such as when we impose a gas guzzler tax to reduce fuel consumption while we simultaneously subsidize oil production to increase output.

Energy tax policies should instead address the sizable external costs of energy consumption, such as the costs associated with climate change and in particular pollution by implementing a carbon tax that encourages consumers and producers to reduce emissions through market incentives. However, the presence of fossil fuel subsidies in the current Tax Code contradicts this goal.

Most fossil fuel subsidies are implemented as tax expenditures in our Tax Code. The Joint Committee on Taxation, which I will refer to as JCT, defines a tax expenditure as a provision that deviates from their baseline income tax. If one considers a consumption tax as a baseline tax system, then many current provisions would not qualify as tax expenditures.

Furthermore, several fossil fuel tax expenditures apply to other industries within and outside the energy sector, so their magnitude depends on whether one is interested in their overall size or the size compared to subsidies granted to other industries.

³Prepared statement of Dr. Gayer appears in the appendix on page 34.

There are four significant types of tax provisions for fossil fuels: cost recovery, the treatment of inventories, the treatment of foreign profits and tax credits. JCT classifies most provisions within these categories as tax expenditures. According to JCT, the total value of fossil fuel tax expenditures from 2022 to 2026 will be approximately \$12 billion. However, this estimate would be smaller if one considers the size of these expenditures relative to other industries. For example, the last in, first out accounting method in some accelerated depreciation provisions apply to all industries under current law.

It is also worth noting that not all oil and natural gas companies can fully benefit from these tax provisions. For example, small non-integrated oil and gas producers get a more generous treatment than big integrated oil and gas producers in expensive and intangible drilling costs.

Fossil fuel subsidies are unlikely to help increase production in the United States significantly. The Congressional Budget Office estimates that fossil fuel subsidies led to a minimal impact of about a half a percent more domestic oil production. The U.S. Treasury and academic studies, such as the one Senator Whitehouse alluded to, also finds similarly small effects of these subsidies on domestic production.

This means that they currently do not achieve the goal of insulating domestic prices from foreign supply disruptions, particularly since prices are determined in the global market.

In conclusion, fossil fuel subsidies move us away from energy prices that accurately represent the extensive external costs associated with their use. My preferred policy is a border adjusted carbon tax that creates incentives to account for the costs for energy use.

This would provide incentives for businesses to innovate, to use cleaner energy sources and to invest in more carbon efficient production techniques.

Mr. Chairman, Ranking Member Grassley, thank you once more for the opportunity to speak today, and I look forward to the questions.

Chairman WHITEHOUSE. Thank you, sir. Dr. Deziel.

STATEMENT OF DR. NICOLE DEZIEL, PhD, MHS, ASSOCIATE PROFESSOR, YALE SCHOOL OF PUBLIC HEALTH, DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCES, YALE SCHOOL OF THE ENVIRONMENT, YALE SCHOOL OF ENGINEERING & APPLIED SCIENCE, DEPARTMENT OF CHEMICAL AND ENVIRONMENTAL ENGINEERING ⁴

Dr. DEZIEL. Chairman Whitehouse, Ranking Member Grassley, and distinguished Members of the Senate Budget Committee, it is an honor to participate in today's hearing.

My name is Nicole Deziel, and I am an Associate Professor at the Yale School of Public Health in the Department of Environmental Health Sciences. My testimony will address the human health impacts of oil and gas development.

These remarks are informed by a strong body of evidence, including my own 9 years of research and more than 25 publications on

⁴Prepared statement of Dr. Deziel appears in the appendix on page 41.

the exposures, health and environmental justice impacts of oil and gas development. I have five key points to share today.

First, living near an oil and gas development has been associated with a range of health problems, with the greatest evidence of risks reported for children. In 2021, there were nearly a million oil and gas wells in operation and approximately 18 million U.S. residents living within one mile of an oil and gas well.

More than 50 peer-reviewed epidemiologic studies, including some from my own research group, provide evidence of a relationship between oil and gas development and adverse health outcomes such as birth defects, childhood leukemia, hospitalizations, asthma exacerbations, mental health issues and mortality among the elderly. The weight of evidence indicates that the risk of adverse health outcomes increases with the greater proximity to, or density of, oil and gas wells around people's homes.

The strongest evidence is for health in newborn babies, such as birth defects, preterm birth and low birth weight. Such associations have been observed across numerous states including Pennsylvania, Colorado, Ohio, California, Texas and Oklahoma. The consistency of results across multiple studies that were conducted using different methodologies, in different locations, during different time periods and different populations provides confidence in this body of research.

Two, a growing number of environmental monitoring studies have concluded that oil and gas development contributes to air pollution, noise, odors, water contamination, radioactive releases, seismic activity and increased traffic.

Three, exposures and health risks are not distributed equally across communities, with disproportionate impacts for some disadvantaged populations. As we have seen time and time again with other industrial and hazardous sites, certain subgroups of the population, such as communities of color or lower income bear a disproportionate burden of exposures and health risks from oil and gas development.

For example, studies in Texas and Ohio demonstrated that oil and gas wastewater disposal wells were more likely to be sited in communities of color or areas of lower income. In Texas, Hispanic populations were more likely to be exposed to flaring, a practice of burning excess gas, yielding light at night, noise and noxious odors.

We found that communities with a higher proportion of lower income and elderly populations in rural areas were the most vulnerable to groundwater pollution from hydraulic fracturing in the Appalachian Basin.

Finally, a recent California study found that Black, Hispanic, and socioeconomically marginalized people had disproportionately higher exposure to oil and gas wells.

Four, the limited availability of monitoring data, particularly in rural areas where substantial drilling occurs is a challenge to understanding the hazards and risks fully.

Five, multiple complementary strategies would more adequately address oil and gas hazards and better protect community health.

One of the most commonly used policy protections for communities near oil and gas wells currently are setbacks, which is the

allowable distance between an oil and gas well and a sensitive receptor, such as a home or school.

The utility of setbacks is based on the premise that hazards emitted by oil and gas operations attenuate with distance. While setbacks do offer critical public health protections to nearby communities, many states have not updated them to reflect the current science. And it is challenging to establish a universal distance that protects against all hazards because hazards decrease at different rates. Furthermore, setbacks do nothing to prevent the release of methane or other greenhouse gases that contribute to climate change.

In conclusion, there is clear evidence for health hazards from oil and gas development, and these are not being adequately addressed by current policies. Thank you. And I look forward to your questions.

Chairman WHITEHOUSE. Thank you, Doctor. And now Ms. Furchtgott-Roth, welcome.

STATEMENT OF DIANA FURCHTGOTT-ROTH, DIRECTOR, CENTER ON ENERGY, CLIMATE AND ENVIRONMENT AND THE HERBERT AND JOYCE MORGAN FELLOW IN ENERGY AND ENVIRONMENTAL POLICY, THE HERITAGE FOUNDATION⁵

Ms. FURCHTGOTT-ROTH. Thank you very much, Chairman Whitehouse, Ranking Member Grassley. Thanks for giving me the opportunity to testify today about who pays the price of President Biden's energy policies.

I direct the Center for Energy, Climate and Environment at The Heritage Foundation, and I am an Adjunct Professor at George Washington University.

Let me start out by saying that I am an American due to fossil fuels. My father on a job interview here in 1967 was so impressed that Americans heated their bathrooms that he moved his whole family here from London.

In London, my dad heated the house with kerosene heaters, filling them up every night, which gives me a profound appreciation both for fossil fuels and for central heating systems.

Poor and middle class people pay a steep price for President Biden's energy agenda. They suffer a decline in value, safety and security while the regulations do not mitigate climate change because emissions are simply displaced to China and other poorer countries.

Americans' oil and gas jobs are being sacrificed to Chinese making wind turbines and solar panels. Americans' auto jobs are being sacrificed to Chinese making batteries and mining for rare earth minerals. Sometimes Chinese slaves and child workers are taking these American jobs. We are supposedly doing all of this to improve the climate, but displacing energy intensive manufacturing to China does not reduce global emissions.

In order to produce renewables, China is increasing its construction of coal-fired power plants. America has 225 coal-fired power plants, and China has over 1,000. That is half of all the coal-fired power plants in the world. That is one reason why China has in-

⁵Prepared statement of Ms. Furchtgott-Roth appears in the appendix on page 57.

creased carbon emissions by over 5,000 million metric tons over the past 16 years while America's carbon emissions have declined by 1,000 million metric tons due to the use of our clean natural gas.

Last week, Stellantis, after closing an Illinois plant in December, announced it would be cutting 3,500 jobs due to its forced transition to electric vehicles. GM and Ford are also laying off workers for the same reason.

United Auto Workers President Shawn Fain said on April 26, "this is a slap in the face to our members, their families, their communities and the American people who saved this company 15 years ago. Even now politicians and taxpayers are bankrolling the electric vehicle transition, and this is the thanks the working class gets."

In April, the Joint Tax Committee estimated that green tax credits from the Inflation Reduction Act will cost taxpayers \$570 billion from 2023 to 2033. As of 2022, wind and solar power produced less than 6 percent of our domestic primary energy consumption. The reality is that the federal government is spending billions on renewables, making electricity disproportionately more expensive for poor people.

Fossil fuel companies generate tax revenues for federal, state and local governments. The oil and tax and gas extraction industry paid 19 percent of income in federal taxes in 2018 compared to 11 percent for industries as a whole.

In order to comply with EPA's recent proposed rules to regulate tailpipe emissions, 60 percent of vehicles would have to be battery powered electric in 2030. These regulations would make new and used cars disproportionately more expensive for the poor and middle class people who can least afford them.

The Department of Energy also wants to regulate other appliances, depriving Americans of the ability to have a simple gas stove. Poor and middle class people will be disproportionately paying higher appliance prices.

Fossil fuels are essential for fertilizers and agriculture. If the world gives up its agricultural security, countries will see higher food costs and decreased food access with poor people disproportionately paying the price for higher food costs. Already this year U.S. food prices have risen over 8 percent. Eggs are over \$4 a box, and milk is \$4 a gallon.

President Biden's plan to transition away from fossil fuels is making the United States weaker and China stronger without noticeable effects on global temperatures.

Thank you for allowing me to testify today.

Chairman WHITEHOUSE. Let me begin with a few questions for Dr. Gayer if I may. Doctor, your doctorate is in economics, correct?

Dr. GAYER. Yes, sir.

Chairman WHITEHOUSE. Could you explain what economists mean by the term externality, particularly in the context of fossil fuels?

Dr. GAYER. I would be delighted to. I will do it in economist talk. You actually did a much better job, I think, when you talked about subsidizing the license to pollute for free. The idea of textbook economics is you want the market price to reflect the cost of producing the good that you are selling.

And in most cases, the market does a fine job of that, and we would not need to have any hearings or, I would hope, government involvement in it. But we need to account, especially when it comes to certain environments, that when a production process is causing health costs, such as Nicole had referred to, or climate costs, as you and I had talked to, those costs are not going to be reflected in the market price.

And so the economic prescription for that is simple, which is to try and set a tax equal to that price, so not to shut down a market, not to penalize unnecessarily. It is not a matter of retribution. It is a matter of what makes good economic sense, and it accounts for the cost of the production of a good. So that is internalized into the production and consumption decisions. And it relies on the power of prices in order to allocate these goods accordingly.

Chairman WHITEHOUSE. Simply put, if you had two factories on the same river, and one was throwing all of its trash and waste into the river and the other was paying to have it cleaned up, that would be an unfair subsidy of the one that was throwing all of its trash and waste in the river, correct?

Dr. GAYER. Yes. That is much more elegantly put than my textbook example, but yes.

Chairman WHITEHOUSE. If we were to do a carbon price, that creates the risk of giving advantage to overseas competitors.

Dr. GAYER. Yes.

Chairman WHITEHOUSE. And your testimony calls for your carbon price idea to be border adjusted.

Dr. GAYER. Yes.

Chairman WHITEHOUSE. Could you explain what you mean by it being border adjusted and what kind of effect that would have on pollution from other countries, specifically China and India?

Dr. GAYER. Yes. So one of the attributes of a carbon tax is relative to a lot of other policies, it is actually not super complicated to administer. You levy the tax at the source. If it is a domestic source, you levy it at the coal mine or the well head. But if you were to just stop there, then imported goods would not—their prices would not reflect the carbon content of their goods and, as you said, would give an unfair advantage to foreign imports.

And so the idea of a border adjusted tax is to make sure that any goods that we import, their costs reflect the same external that domestic producers are facing. And so you would adjust the tax and make sure that they are subject to the same tax.

The advantage of doing so, I would say, are twofold. One is in the realm of economics. As you said, it doesn't—it would alleviate or eliminate any competitive advantage that foreign companies would have in exporting to the United States if we had a carbon tax.

And, two, it's less about economics and more diplomacy. And we need to get it to the world where we are leading the world in addressing climate change and doing so and levying a tax internally and also on products that people sell to the United States is a clear signal that we need reciprocity and this needs to be a global solution.

Chairman WHITEHOUSE. You just passed its carbon border adjustment mechanism. They call it their CBAM. That will put tariffs

on United States goods and far steeper tariffs on Chinese goods. And they suggest that will move the European supply chain from China to the United States, increasing jobs and manufacturing here in the United States, specifically in steel, aluminum, cement, pharma and other, you know, major industries. Does that sound right to you and how would domestic industries benefit—

Dr. GAYER. Yeah, I—

Chairman WHITEHOUSE [continuing]. From carbon border adjustment?

Dr. GAYER. I don't know the particular of their pricing, but it does sound right to me. And I believe their pricing is again reflecting the relevant carbon content of the goods that China versus the U.S. exports. And to the extent that we are less carbon intensive than the Chinese, we would be subject to less of a levy, which would make us more competitive on those industries.

Chairman WHITEHOUSE. Dr. Deziel, your publications that you mentioned are peer reviewed?

Dr. DEZIEL. That is correct.

Chairman WHITEHOUSE. What does that mean to the laymen listening?

Dr. DEZIEL. Yes. Peer review is the process we use in the scientific community to ensure the quality of existing research. So when we submit journals for publication, they undergo intense scrutiny from multiple other scientists who are not involved with the work to check the numbers, check the assumptions, check the interpretation and make sure the studies are valid.

Chairman WHITEHOUSE. Your work focuses on your multiple observations. The proximity to oil and gas production facilities has enormous health effects, adverse health effects on children. What would you say is the specific vector for that and with specific reference to methane, if you would?

Dr. DEZIEL. Yes. Thank you for the question, Senator. Oil and gas releases so many hazards that it is quite complex. There is potential for air pollution, the methane emissions, water contamination, the stress of having your community disrupted, increased traffic.

So most studies have not pinpointed the exact factor and likely it is a combination of multiple factors that are contributing to some immediate harms, like birth defects, but also methane is contributing indirectly. It is not toxic to children who live nearby, but it is contributing to climate change, which is certainly harmful for the next generation.

Chairman WHITEHOUSE. Senator Grassley.

Senator GRASSLEY. Thank you very much, Mr. Chairman. My first three questions will be to Ms. Furchtgott-Roth. We have heard references to an International Monetary Fund (IMF) study that claims the fossil fuel industry receives \$660 billion in annual subsidies from our country, our government.

According to President Biden's own budget, repealing all specific oil and gas related tax preferences would raise only \$45 billion over 10 years, a far cry from the \$660 billion. Would you please explain how the IMF arrives at this ridiculous inflated figure?

Ms. FURCHTGOTT-ROTH. Sure. Yes, thank you for the question. Well, this is a working paper that does not represent the view of

the IMF, as its authors say at the beginning, and it has not been peer reviewed or published in a peer reviewed journal the way that Dr. Deziel's articles have been.

Several features of the working paper are worth noting. China has \$2.2 trillion in subsidies. The United States supposedly has \$660 billion in subsidies. The IMF uses the word subsidies to include not just direct taxpayer support for fuel use, but an estimate of environmental costs for the combustion of the fuel.

Nearly half of the subsidy calculations are related to coal use. In fact, to the extent that onshore and offshore oil and natural gas development provides additional volumes of natural gas that can substitute for coal combustion, it would substantially lower the IMF estimates of the effective subsidy.

In addition, the report makes no adjustment for revenues collected by federal, state and local jurisdictions for oil and gas development of public and private lands. And according to the Department of Interior, the federal government alone collected over \$100 billion in oil and gas revenues between 2005 and 2015.

A further limitation of the paper is it doesn't effectively address uncertainty in calculations from the environmental costs of oil and gas use, especially given advances in control technologies.

The paper has no estimate of environmental costs from wind or solar or hydropower. It discusses benefits of making fuel more expensive but not benefits of making it less expensive. No estimate of benefits from fossil fuels, such as availability of electricity, drinking water and sewage system, cooking systems, rather than wood or dung, health benefits or benefits from the idea of manufacturing jobs are given by the IMF paper, and there are many benefits from fossil fuels.

Senator GRASSLEY. Agriculture is very important to Iowa's economy. Over the course of these climate change hearings, we have heard from Democrat witnesses who support market altering and consumer policies to limit fossil fuel consumption and drive down emissions.

Conveniently, they ignore the devastating impact that their policies would have on working class Americans and small businesses, including family farmers. What role do fossil fuels play in maintaining food security, domestically and abroad? And I know you touched on this a little bit in your opening statement.

Ms. FURCHTGOTT-ROTH. Yes. Not only our energy security, but our agricultural production and food security depend on fossil fuels. Raising the price of fossil fuels raises the cost of food and poor and middle class people pay the price.

Fossil fuel is essential for food production because of nitrogen used in fertilizers. In 2021, Sri Lanka President Rajapaksa banned synthetic fertilizer and pesticide imports.

Prices rose in Sri Lanka, and there were riots.

Protests are also occurring in the Netherlands and in Belgium as policymakers attempt to curtail fossil fuels in agriculture. Farmers are rioting because they are losing their livelihoods in the name of fighting climate change as European governments seek to reduce emissions of nitrogen oxide and ammonia, which are vital inputs to modern agriculture.

European farmers are being told that because of the aim for NetZero emissions, their industry is being phased out. And this disproportionately hurts poor people, who have to pay more for food and who cannot afford to do so.

Senator GRASSLEY. The Biden EPA recently proposed a new emission standard for light and medium duty vehicles. This rule would require two-thirds of the new cars to be electric by 2032. Given your background as an economist, can you speak to this rule's feasibility and the cost it would impose on our economy and the consumer?

Ms. FURCHTGOTT-ROTH. It would impose massive costs on the economy. It would require 60 percent of new vehicles sold to be battery-powered electric in just 7 years and right now 6 percent of vehicles sold are battery-powered electric.

These new electric vehicles cost more, and charging also costs more. Used electric vehicles will be hard to find, and most Americans buy used vehicles, with electric vehicles you don't know how long the battery is going to last. And electric vehicles take longer to recharge. They don't go well in cold climates. That is why there are only 510 of them in Wyoming and fewer in North Dakota and South Dakota because the range is very limited.

They harm the environment through mining for minerals.

And many of these minerals are mined with child labor or slave labor.

Electric vehicles will make America weaker and China stronger because the electric batteries and components are made in China as opposed to oil and natural gas, which is produced by Americans with well-paying jobs here in the United States.

Senator GRASSLEY. Thank you.

Chairman WHITEHOUSE. Senator Kaine and then Senator Johnson.

STATEMENT OF SENATOR KAINE

Senator KAINE. I want to thank the Chair for calling this important hearing. When we talk about things like externalities and social costs, it can often seem like a theoretical concern and some of the discussions that I have been in about climate change over the years has suggested that it is a tomorrow issue. But I just want to tell you in Virginia, it is a today issue.

We have one of the most vulnerable parts of the United States in terms of sea level rise in the Hampton Roads area. And in Appalachia we are seeing extreme weather patterns that are creating more and more events of extreme rain, flooding that damages homes, people's livelihoods, infrastructure, schools and roads.

Interestingly enough, some of the rain data in Virginia on an annual basis is not changing that much in these communities. It is just that the frequency, the randomness, the severity of storms is changing, and the infrastructure was not really built for that.

And so now when we talk about climate change in Virginia, including in some areas that have traditionally been producers of fossil fuel, the coal fields of southwest Virginia, people understand it is not a tomorrow issue or it is not somebody else's issue. It is theirs.

We also see species disappearing in our National Park species that require a certain temperature level to reproduce. As temperatures rise, they have to move higher and higher up in the Shenandoah National Park, for example, and eventually the acreages where they can live and reproduce are disappearing.

We also in Virginia see the effects of fossil fuel industries in other ways. Black lung disease affects those who mine coal. If you mine Appalachian coal, you have about double the change of getting black lung disease as miners of coal in other parts of the country because of the way the coal was set up and the other components that are there. So these are very, very serious issues and important to us.

If I could ask, to Dr. Gayer and Dr. Deziel, when Congress has programs that address the social cost of a specific activity, such as black lung treatment and benefits related to coal mining, can you talk about why it is important to ensure that we internalize the cost with policies such as this?

Dr. GAYER. Thank you, Senator. First, I think you remind me of an occupational hazard of being an economist, which is I intend to talk in theoretical concerns. So I appreciate the reminder that we all need every day, these are real people facing real harm.

Having said that, I am going to slip back into technical terms. The reason why we need to reflect the true cost of our activities, including our burning of fossil fuels, is for everything that you alluded to. This is an activity that causes real damages, not just in the sense of global climate change, but in the local pollutants that my colleague here Nicole was talking about and as you alluded to.

And so the kind of pointed headed academic textbook answer at its heart is to help real people and to have a flourishing, dynamic economy that accounts for the costs of the activities that spur that economy. And that's why, as I said before, the policies that we need to look at or that I would recommend for all of you is to ensure that the burning of fossil fuels accounts for those costs, those very real costs, that affect Americans.

Senator KAINE. Dr. Deziel.

Dr. DEZIEL. Thank you so much, Senator, for raising the issue of the workers. The oil and gas extraction workers have a high fatality rate. Workers die each year from explosions, falls, vehicle accidents and then there are also the exposures from all the chemical hazards. They are closest to the hazards, whether it be fencing, hydrocarbons, silica dust, which also causes lung diseases. And the workers are often overlooked and understudied. Most of the health research has really focused on the community in part due to difficulty accessing worker sites.

So I think this is an extremely important issue that should be factored into these analysis.

Senator KAINE. And if I could say, Mr. Chair, the reason that I appreciate you doing this hearing is we have proven unable during my time in the Senate to do big meaningful climate legislation in a bipartisan way.

The first climate bill that was introduced in the Senate was a bipartisan bill, John Warner and Joe Lieberman. But we have been unable to do it in a bipartisan way. We were able to make some significant advances in the Inflation Reduction Act. And we did

some things in the Infrastructure Bill that had bipartisan votes that can help us.

But we do climate legislation a lot if you count coming in after the fact to try to do a flood insurance program, to try to do a Superstorm Sandy cleanup package, to have a Black Lung Benefits program. We don't do the prevention and go at root causes very well. But we are willing to do legislation at the back end when it's really expensive to do it often.

And I appreciate the fact that we can bipartisan votes for a flood relief or Black Lung Benefit program or, you know, other programs on the back end. I just am convinced we need to move on the front end, and this hearing helps focus on that. And I appreciate it, and I yield back.

Chairman WHITEHOUSE. Thanks, Senator Kaine. Senator Johnson.

STATEMENT OF SENATOR JOHNSON

Senator JOHNSON. Thank you, Mr. Chairman. Dr. Gayer, you are an economist so I want to go compare and contrast fossil fuels versus green energy in terms of subsidies, in terms of externalities, in terms of benefits. So let's first talk about the cost of subsidies.

In your testimony, you said that the subsidies in the U.S. for fossil fuel is about \$12 billion over 5 years, correct? The Inflation Reduction Act, I think it is over 10 years, about \$400 billion, but a Goldman Sachs study said it would be closer to \$1.2 trillion. So just compare that \$12 billion versus \$1,200 billion worth of costs is sure subsidizing a whole lot more green energy, correct?

Dr. GAYER. According to those numbers, yes.

Senator JOHNSON. One hundred times higher cost and that's just one piece of legislation. Let's talk about the benefits. I mean, it's undeniable that fossil fuel is going to power 80 percent of our economy decades into the future, correct? So when you are powering 80 percent of the economy, you're, oh, I don't know, paying for air conditioning to allow people to escape the heat.

Certainly, China and India are going to use fossil fuels to lift their people out of poverty. Mr. Gayer, do you believe there is any chance whatsoever that India and China are going to stop using fossil fuels?

Dr. GAYER. Nor do I think we will, yes.

Senator JOHNSON. Zero chance of that. Okay. Are you aware of the climate alarmist studies? Their own models show that even if we eliminated all CO2 emissions in the United States, it would have a negligible, less than a degree difference, in terms of what their projections say in terms of climate change?

Dr. GAYER. I don't know which models you are referring to. I don't think that's true.

Senator JOHNSON. Pardon?

Dr. GAYER. I don't think that's true. But I don't know what you are referring to.

Senator JOHNSON. Oh, it's true. Again, if you look at—

Dr. GAYER. I have to make a—

Senator JOHNSON [continuing]. So my point being, okay, we could eliminate all of this. We could shoot ourselves in the foot. Spend

\$1.2 trillion, have no impact on climate whatsoever and still have 80 percent of our power provided by fossil fuel. I think that's crazy.

Now let's talk about externalities. Okay? No doubt about it, and I think it would be nice to be able to figure out some way to price that in, but, you know, the pollution from the extraction of fossil fuels plus the pollution from burning them, again I acknowledge that, but there are also externalities to green energy, correct?

Here is one right here. This is a photo of a cobalt mine in the Congo. There is child abuse going on here. This is child labor. Is that okay because it's just not occurring in the U.S.? Why are we not accounting for all the mining that is going to be required to provide the copper, the lithium, the rare earth minerals, the cobalt? Have you studied that cost of externalities? Have the climate alarmists studied that? Are they accounting for whatsoever not to mention the impracticality of actually mining enough to produce the number of electric vehicles they are contemplating? Ms. Roth, can you speak to that?

Ms. FURCHTGOTT-ROTH. It is very important to be able to take into account all of these different costs of mining. And I find it very surprising that people who are against coal mining in the United States are in favor of mineral mining in the Congo—

Senator JOHNSON. Because it's happening someplace else?

Ms. FURCHTGOTT-ROTH. It's happening someplace else, exactly.

Senator JOHNSON. Again, I think it is kind of grotesque, pretty arrogant. Dr. Deziel, can you tell me, what is the biggest adverse event? What is the major one that you are finding your studies from fossil fuels?

Dr. DEZIEL. The strongest evidence is for risk to children, like preterm birth and birth defects.

Senator JOHNSON. Okay. So what is the background rate of the birth defects that you are talking about? What is the background rate?

Dr. DEZIEL. Birth defects are quite rare, but we see an additional increase—

Senator JOHNSON. Okay. So I'm asking what is the background rate of a birth defect rate in hundreds of thousands? I mean, what's that background rate?

Dr. DEZIEL. Well, I can double-check on the statistics.

But I think—

Senator JOHNSON. This is your study.

Dr. DEZIEL. Yes, about 3 percent of births have a—

Senator JOHNSON. Okay, 3 percent. Okay. What is it then due to—in your studies, how does that increase? What does it go to? Does it go to 5 percent or 6 percent? Or what is the increase off of that 3 percent?

Dr. DEZIEL. Thank you, Senator. In the studies, we find that there is about a 20 percent increase in risk, which is not to say the 20 percent increase in number of cases, but there is a 20 percent greater chance of birth defects in children whose mothers live—

Senator JOHNSON. So that means it would go from 3 percent to 3.6 percent? Again, I am trying to understand your study.

It is very easy to play with statistics. It is very easy to scare-monger, which is what climate alarmism is all about. But you have

to actually take a look at the reality of the situation. Again, China and India are not going to stop using fossil fuels, nor are we.

So we can continue to spend trillions of dollars and have no impact on any of these things or we can actually concentrate on the things we can fix. And, again, if there are some real problems, you know, living around drilling that is something we can fix without spending \$1.2 trillion. So, again, I'm trying to figure out what is the reality situation here? What does your study actually show?

Dr. DEZIEL. Well, and my study and others we see——

Chairman WHITEHOUSE. You may answer the question and then it is Senator Marshall's turn.

Dr. DEZIEL. Thank you. Yes, we see up to—for another example, in another one of my studies we saw a doubling of risk of childhood leukemia in children whose mothers lived within 2 kilometers of oil and gas sites. And this is consistent across more than five epidemiological——

Senator JOHNSON. Well, I would like to see your actual data. I don't like the percentages. I want to see the data.

Okay. Thank you.

Chairman WHITEHOUSE. Senator Marshall.

STATEMENT OF SENATOR MARSHALL

Senator MARSHALL. Thank you, Chairman, and I am sorry to pick on you, Dr. Deziel, but I also want to follow-up on the studies. I didn't know that is where my colleague was going to take you. How many of your studies you talked about did multi-regression analysis?

Dr. DEZIEL. Most of the 50 studies that I have been referring to used multiple regression analysis, meaning they controlled for many other——

Senator MARSHALL. I know what it means. And you mentioned the word association as opposed to statistically a difference.

Dr. DEZIEL. Mm-hmm.

Senator MARSHALL. So did any of these have a statistical difference or were they all just associations?

Dr. DEZIEL. Most of the studies observed statistically significant associations, meaning an increased risk of health——

Senator MARSHALL. Well, that's two different—you're the epidemiologist, but those are two different terms from a study to say if there is an association versus statistical difference, meaning two standard deviations outside of the mean.

Dr. DEZIEL. Most of the studies did observe statistically significant——

Senator MARSHALL. Then why in your testimony did you use the word just associated?

Dr. DEZIEL. Just trying to use simple terms.

Senator MARSHALL. Okay. All right. That's helpful. So much of this is done with religion as opposed to science so we are trying to see where we can agree on the science.

Dr. Gayer, for you, you are the economist here, two of the tax benefits that are often talked about are the percentage depletion allowance and the intangible drilling cost. If we eliminated those, how would they impact someone like Exxon or Shell, Chevron, some of those big oil companies?

Dr. GAYER. Marginally. I think every study, if you look at the full suite of tax expenditure subsidies, have only a marginal effect on promoting production. So it would increase their tax bill for sure. But as far as production and prices go, it would have a de minimis effect.

Senator MARSHALL. So my understanding that the folks that benefit from these, from the bottom line, are the small producers. Small producers like in Kansas making five or ten barrels per day and that these larger companies don't benefit from them. So I think that's a common misconception. And I think it is so important for national security that we have more than four big oil companies making oil and gas for this world and that these small oil producers need those to stay in business.

I want to talk about methane for a second as well and probably go back to Dr. Deziel. A third of the methane produced in this country is from wetlands and about 20 percent from city landfills. You spoke about methane in particular. Did your studies take that into account? Were these locations close to some type of wetlands or to city landfills as well?

Dr. DEZIEL. Thank you for the question. Actually, my studies did not focus on methane. My studies focused on more of the hazardous emissions coming from oil and gas sites. Methane contributes to climate change so in that sense it is hazardous, but my studies looked at the more immediate consequences of exposures to toxic.

Senator MARSHALL. But certainly methane is one of the major, you know, concerns for greenhouse gases from the oil and gas industry. You know, certainly, the oil and gas industry needs to own that, that about a third of them do come from the oil and gas industry, but a third of them come from wetlands as well.

So are you suggesting we should, like, I don't know, what, bulldoze in the wetlands, too? It's a rhetorical question. I shouldn't have asked it as well.

So often in this world we live in in D.C., we try to think about the environment in different perspectives. And certainly, I just want the chairman to know, my friends across the aisle that I want to leave this world cleaner, healthier and safer than we found it. But also we need to think about affordability and reliability when it comes to energy as well, that this administration's policies have been an attack on certainly American energy. It's been an attack on American agriculture, and it has been an attack on the hardworking Americans as well.

When we see grocery prices going up 20, 25 percent.

Energy costs, oil and gas, utility costs as well, going up over 30 percent, that is an attack on hardworking Americans. So I guess my question is, when we make policies, do we ever think about the affordability and the reliability of energy as well?

I think I will just leave it there. Thank you, Mr. Chairman.

Chairman WHITEHOUSE. The question was rhetorical? You're not seeking an answer from any of the witnesses? The question was rhetorical, just to be clear.

Senator MARSHALL. It is not rhetorical. I think I was just out of time and trying to be respectful of our time.

Thank you.

Chairman WHITEHOUSE. Okay. I think next up is Senator Luján.

STATEMENT OF SENATOR LUJÁN

Senator LUJÁN. Chairman, thank you very much and thank you and Ranking Member Grassley as well and all of the panelists that are with us today.

Dr. Gayer, I particularly appreciated your statement that energy policy should account for the sizable external cost of energy production. We know what these costs are. The cost is climate change. The cost is air pollution. The cost is damage to our environment as well.

One of the costs that I have tried to address is the cost of oil and gas wells that have been abandoned by the industry. Too often oil and gas companies fail to plug their wells when production ends. Some of those wells then go to different ownership, but we saw this enormous problem that fortunately colleagues came together in a bipartisan way to agree that they should be plugged.

As a result, the wells pose significant risk to the environment and surrounding communities by leaking toxic chemicals into the air, contaminating groundwater and contributing to climate change through methane emissions. One of the abandoned wells that I visited before passage of the bill was in an area where there was cattle grazing. And anyone that is familiar with these wells knows that there is a bucket, if you will, that is connected to the tank where a truck will go up, and they connect.

While this particular well had been abandoned, the cattle were still eating in the area, and they were drinking from that bucket. And there was a lot of stuff in there, as you can imagine. And so that is just one example of a challenge that I witnessed personally that needed to be fixed.

So millions of abandoned wells across the nation needed to be cleaned up, hence working together in a bipartisan way on the Regrow Act.

This bill provided \$4.7 billion to plug oil and gas wells that were abandoned by those who profited from leaving this mess behind. This wasn't about leaving things better than you found them. This wasn't even cleaning up after yourself.

Now under current statute, we have no choice but to remediate them at taxpayer expense to prevent the continuing suffering of disadvantaged communities. So my question, Dr. Gayer, is yes, or no, is it irresponsible of energy companies to abandon their oil and gas wells and force taxpayers to pick up the tab for cleanup?

Dr. GAYER. I don't know the particular examples. My short answer is yes. My long answer is, yes, I think you are right. This is an issue that carbon taxation has lots of merits, but it is not going to meaningfully address the concern of abandoned wells. So regulatory, legal liability and in this case, public funding to clean up the mess, I think, is the right way to do it.

Senator LUJÁN. You touched on my follow-up question, which was do you believe that operators should be held responsible for their activities' impacts upfront before drilling begins rather than offloading the burden on taxpayers?

Dr. GAYER. So once of the risks is—you are asking a legal question to an economist so I don't know the legal aspects and I don't know what the current existing law is. But certainly, we should have a legal apparatus where you cannot abandon harmful mate-

rials and leave it to either harm people or for the federal government to intervene ex-post.

Senator LUJÁN. I appreciate that. Dr. Deziel, last year Congress passed the Inflation Reduction Act. And this historic piece of legislation is accelerating the transition to a clean energy economy, creating millions of good paying jobs and providing cleaner air and better health for us.

There was a substantial investment, \$369 billion in production and investment tax incentives to promote technologies that improve air quality and reduce emissions.

Yes or no, will the Inflation Reduction Act improve public health by reducing air pollution?

Dr. DEZIEL. Thank you, Senator. Emission, I mean, engineering controls, like emission controls that can be implemented at oil and gas sites, is certainly an important public health tool for the fossil fuel industry. However, it is not enough. These devices only capture certain pollutants like air pollutants or potentially methane. They do nothing to address noise, water contamination, traffic, the degradation of the landscape. So they are an incomplete solution to the public health issue of oil and gas extraction. They would have to be coupled with some other strategies.

Senator LUJÁN. Do you think repealing the Inflation Reduction Act would damage the health of citizens across the country, especially children and the elderly?

Dr. DEZIEL. I think we need as many protections, layers of protections, as we can get, including air emission controls to protect public health.

Senator LUJÁN. Why do we need more protections? Why do we need more of those tools?

Dr. DEZIEL. Well, oil and gas sites have been shown to emit toxic air pollutants and methane. There are many studies have concluded that.

Senator LUJÁN. So if there are fewer of those protections, then that would lead to a concern with public health?

Dr. DEZIEL. Yes. Fewer protections would mean more exposures and health risks to nearby communities.

Senator LUJÁN. I appreciate it. Mr. Chairman, that sounds to me like if there was a repeal of the Inflation Reduction Act that it would create damage to the health of citizens and the elderly and children as well.

I thank you for the time, and I appreciate the panelists being here.

Chairman WHITEHOUSE. We turn to Senator Braun.

STATEMENT OF SENATOR BRAUN

Senator BRAUN. Thank you, Mr. Chairman. I have been listening to the entire conversation, just not from here. But I have been involved in it as a Republican from almost the time I got here in the U.S. Senate. And my interest in climate goes way, way, way back further than that.

So I have never seen anything where there could be two more disparate views. And you heard it, I think, eloquently from the Chairman and Ranking Member Grassley earlier. The question is how do you sort through all of this? What is the truth?

This is the Budget Committee. I am going to weave it back into that discussion here in a moment. But the fact is for as long as we have been talking about it, whatever modeling has been out there has probably not been that good because it has not, I think, created enough urgency for many that dismiss the idea as even being out there worth discussing.

And on the other side, I don't think it is given enough certainty to where you do what we have done so far, which is give so much advantage to our geopolitical competitors that are the gross emitters that are there growing their economies, building coal-fired plants nearly weekly in places like China and India. So how do you sort it all out?

Well, I think then you have got to come back and take what has been kind of weak information, modeling that if it was that good, the case would be made. And how do you survive into the future to do something about it?

Then let's look at what else is in play. This comes back to budget. We are currently running \$2 trillion deficits. And I think if the other side of the aisle had its ways, it would even be deeper than that because there would have been more legislation based upon borrowing money on something that is a little amorphous in general.

Let's look at the other side. The start of the climate caucus here with Chris Coons back in July, I think, of '19 and there is clear consensus, I think, across the economic community here in this country that something is afoot. When I talk to the main stakeholders, even in places like Exxon,

Chevron, they say there is an issue. They also tell me they have no idea how they are going to get beyond the low hanging fruit, in other words past the things they have committed to do 2030 to 2035. And the consensus I hear mostly is that it is going to take some technological breakthrough that we haven't even found yet. A lot is working there as well.

So do you absolutely plow forward to where it is the concept of present value? Present value in finance means the variables you know about are what is happening closer to the present. In other words if you're spending, investing so much currently, you don't know how it is going to turn out until you get the uncertain cash flow that occurs down the road.

I think that is where we are at. I know as one who got texts when you got involved in climate, have you gone to the dark side? I don't think so. I think we ought to be in the conversation. And I get that politically from young Republicans, young conservatives, faith-based communities, from Evangelicals to Catholics and then you throw farmers in there who are conservative politically by nature who know something is afoot. I am still involved in that, and I would have to agree with that.

But it gets back to my original point. A lot of this is amorphous information that has not been modeled well and then let us come back to the financial point. We are consistently going broke as a country because we are projected to be \$51 trillion in debt in just 10 years. That is close enough to where that is a key figure you can stick into the present value analysis. That is not good.

How do you deal with things out of your control where you've got the two biggest emitters in the future that seem to be giving it lip service only? And in business and anything else you have got to mix the short run survivability with your long-term goals. We should have never gotten rid of our energy independence like we did because I think that has caused political problems across the spectrum, especially on the other side of the aisle.

Budget deficits that look like they are going to worse rather than get better, what do we do with it? Where do we go from here? We obviously don't want to add further to the present value of pain financially. We need to revive whatever it is going to take to have reliable base load production on the electric side. We are going to need—transportation is going to have to be looked at. It would overtax the grid in a way that we couldn't do it, but we still need to navigate towards something that is affordable.

I put this out there now as a statement. I will have a few questions if you are going to do a second round. I want to respect that. But I am saying that the most important thing is we have got to survive into the mid and long-term financially, and we currently don't look like we are doing it in the way we run the federal government in general, whether it is on health care, whether it is on climate, whether it is on anything else we do. I will yield back and if there is time for further questions, I will have a few.

Chairman WHITEHOUSE. I would be delighted to make time for further questions and to have a second round. Senator Kaine will lead off with that. Let me just say before Senator Kaine begins his questioning that I would like to take a moment to express my admiration for you and the sincere and thoughtful way you have addressed these issues. You have been a good person to work with on climate solutions.

And to your point, if I had my way, the debt number would be much higher, I would just like to say I think the debt number would be much lower because I actively support a robust carbon price, and I actively support cleaning up the Tax Code of its many, I would say, corrupting inequalities. And between those two, that would create deficit reducing revenues.

But with that, let me turn to Senator Kaine, and then back to Senator Braun, and then Senator Luján, if he wants.

Senator KAINE. I will be less than a minute. And it is just a point that I wanted to raise inspired by a question that my colleague Senator Luján asked. He asked whether the repeal of the Inflation Reduction Act would have, you know, direct effects on people's health.

And I want to point out in one way it would, and it was one of the lesser discussed parts of the Inflation Reduction Act. Obviously, the IRA dealt with prescription drug costs.

The IRA dealt with clean energy. But the IRA also had a really important public health provision, which is fully funding the Black Lung Benefit program.

That program had been funded on an excise tax on coal extraction. But it was set at a level that fully funded the program, but then that excise tax expired and was not reauthorized. And it rolled way back, which put the burden of the program on the backs of general taxpayers rather than coal companies.

In the Black Lung Benefit—in the Inflation Reduction Act, we did a permanent fix of the financing of the Black Lung Benefit program so that the miners in Virginia and elsewhere who face the significant risk of black lung disease—and in Appalachia, because of the condition I mentioned earlier, folks are getting diagnosed with black lung disease earlier and earlier and earlier in their careers. It used to be something that somebody would get diagnosed with maybe in their late 40s or 50s. It is not uncommon to see coal miners in their 30s now getting diagnosed with black lung disease because of the conditions, the amount of silica and other components that they have to breathe as they are doing coal extraction.

But we have fixed—we haven't made coal mining safer, but we did fix the benefit program so that at least people who get diagnosed can count on the fact that benefit program will be there. If the IRA was repealed, we would go back to a situation where the funding would not be there, and people wouldn't be guaranteed they could have access to a program that would protect their health in the tragic circumstances of black lung diagnosis.

So I just wanted to acknowledge that was a really important part of the IRA, especially in Virginia and other coal mining states. And a repeal would throw that program into jeopardy and thus hurt people.

Chairman WHITEHOUSE. As we switch back to Senator Braun, let me put into the record the announcement from EPA regarding its pollution standards for cars, light duty trucks, reporting that reduced fuel and maintenance costs under the proposed standards would save the average consumer \$12,000 over the lifetime of a light duty vehicle as compared to a vehicle that was not subject to the new standards. And with that, Senator Braun.

Senator BRAUN. Thank you, Mr. Chairman. When it comes to the whole budget discussion, I am going to just briefly give an answer to the Chairman's comment.

Running \$2 trillion deficits, the Trump tax cuts, which by the way were getting close to paying for themselves pre-COVID, that is chump change, \$150 billion per year. So that is only 7.5 percent of our current deficits.

The carbon tax, that is something that, I am not sure how you would model that in terms of what it would do, but until we get our spending in line with historical revenue generation, which has always averaged 17.5 to 18 percent of our GDP other than 3 years in the Clinton Administration, we just don't have an economy that will give us more revenue. And if you do tax it more, you will have lower economic growth over time as another consideration philosophically in terms of what you do with budget.

My question to all three of you would be the fact that you've got the now second largest economy and the soon to become third largest economy, India, which is about ready to eclipse Japan's economy, when they are plowing forward, Senator Johnson talked about some of it, what is happening elsewhere, how do you justify from your own points of view when that is a reality, you can actually put some numbers down there, and where the savings, in terms of what you do by mitigating climate, has got a little more speculation to it?

Give me the pros and cons from each point of view of how we navigate through all of that. And if you want to throw it in the context that we are borrowing nearly 30 cents on every dollar we spend here, which is a budget consideration, if you want to spend money, how do we justify doing that?

We will start over there, Doctor, on the left.

Dr. GAYER. Thank you, Senator. First, I want to commend you for the framing of the problem. You did say that there was no more disparate views. Maybe I am being overly optimistic. I hear equal concern for the welfare of Americans, whether or not it is health or whether or not it is economic.

So I am going to try to sell you a little bit on where I am for a carbon tax. A carbon tax is less intrusive. It will spur innovation. It will protect the economic interests of Americans. It is a simpler approach. I think it's a market friendly approach, that is why I am for it. So the way that I can—

Senator BRAUN. How much roughly a year would you say that is going to generate?

Dr. GAYER. It certainly depends on the tax, but you are right. It is probably in the order of \$100 to \$200 billion, something—and then of course—

Senator BRAUN. And then again, we are talking, just for the record, my Carbon Pricing Bill was priced out at about \$2 trillion over 10 years.

Dr. GAYER. Okay, of revenue.

Senator BRAUN. That would be then in line with 10 percent of our current deficit. So that means it is a lot of room to go from that and say changing tax policy. Still we are spending a lot of money that we can't generate through tax policy. Go ahead.

Dr. GAYER. My point is it helps—

Senator BRAUN. Yes.

Dr. GAYER [continuing]. And also the reducing the fossil fuel subsidies, although not massive, even smaller helps.

Senator BRAUN. But the heaviest lifting would have to be done through spending if you want to get to a balanced budget.

Dr. GAYER. Sure, for taxes. Yes, that's right. So, you know, I guess I am trying to be a little bit more optimistic that there is a policy out there that kind of joins the two sides and their concerns on both the economic and health consequences of our energy use.

On China, I commend you also. It is an issue. It is a global pollutant. We heard today about the local pollutant effects. Those are real. Those have nothing to do with China in the sense that, you know, addressing fossil fuel use here would help the health of Americans in that sense.

But in the global sense, you are right. We have China. We have India. It is a global problem. Again, I think I come from a bit of optimism on my policy here. One, we don't doubt that this is a serious problem so we can't just say because we can't solve the global issues we can ignore it.

I certainly think if we don't have smart policy that addresses the issue domestically, other countries are less likely to act. But indeed reciprocity should be part of it, which is again the border adjustment tax helps with that.

And, again, I will get to what I said before. I think a price signal will lead to innovations. I think it will give you the tech breakthroughs that you said are necessary. I think that is where the answer lies. And quite honestly, as we have seen in other sectors, if Americans have tech breakthroughs, the Chinese will adopt that technology. And so I think there is real hope there as well.

Senator BRAUN. Thank you.

Dr. DEZIEL. Thank you, Senator, for the thoughtful question. I am not an economist so I will just briefly say that the studies that I have cited are not about modeling the future. They are not amorphous. They are about kids who already have cancer, have birth defects, have asthma. So addressing fossil fuel now will have very real impacts to communities today and that energy justice is an incredibly important issue. We all deserve access to reliable and affordable energy, but just not at the expense of fence line communities. Thank you.

Senator BRAUN. Thank you.

Ms. FURCHTGOTT-ROTH. Yes. Thank you for the question. I would say in order to help the deficit, we could repeal the \$570 billion of green tax credits in the Inflation Reduction Act without repealing the whole act, thereby leaving the Black Lung program provision as it is.

I am against a carbon tax because it is regressive. It hurts poor people the most. Their prices go up for appliances, for food, for other kinds of things. The border adjustment, according to the World Trade Organization, might not be completely legal. So we might have foreign products coming in at lower costs than American products.

An additional tax would slow GDP growth in the United States. These taxes are never perfect. And it is always difficult to estimate the amount of carbon in a particular product. And so you might find some exemptions, some not. Most importantly, this is very similar to a value added tax, which we have seen rise over time. They start small.

Europe has a 20 to 25 percent value-added tax that started very small. Canada's rose also. And Congress, you Senators, are unlikely to repeal the income tax or any other tax. So this would be one tax layered on top of another tax.

America's air has been getting steadily cleaner. The six criteria pollutants, if you look at the EPA data, are getting cleaner all the time because of clean, natural gas. If we offshore production to China, they are making these electric batteries, the wind turbines, the solar panels with coal-fired power plants. It is not reducing global emissions or helping climate change.

What we need to do is use our own oil and natural gas resources and encourage other countries to use clean natural gas also either by us exporting it or by us exporting the technology so that they can do fracking also. That would be far more useful than these \$570 billion in green tax credits, many of which, by the way, are going to be benefitting China. EVs now apparently they don't have to be made in the United States to get the credit if they are leased, because they count as commercial vehicles, which opens a loophole

to, again, subsidizing China, making China stronger and the United States weaker. Thank you.

Senator BRAUN. Thank you. And thanks for your comments. And one final conclusion in terms of a comment from me. We are entering into a much broader discussion. It is right in front of us now with what is happening over in the House in terms of debt limit and all of that.

I come from the world of being an entrepreneur with an emphasis on finance. And I can tell you that you can't run any enterprise like we are currently running it. And since the Gulf Wars, to date, we have been taking our country and its balance sheet into a place that regardless of what you want to do here, it's not healthy.

The crowding out effect of interest in and of itself is going to be a heavy weight that gets worse each year. And all I can tell the American public, whoever is listening, the numbers always win. You can't escape them. And currently, we are in a place where we have got time, but it takes political will and discipline just like you would have to exercise in any other venue to kind of rein things back in so that this place is healthy for all the people that look to it for whatever reason it might be. Thank you, Mr. Chairman.

Chairman WHITEHOUSE. Thank you very much, Senator Braun. One clarification, if you don't mind, Dr. Gayer, if natural gas is used as a feedstock for fertilizer and not combusted, does it pay a carbon tax?

Dr. GAYER. It depends where you are administering the carbon tax. So there are different—I am trying to think from memory. If you levy it at its source, then it would be in the price.

Chairman WHITEHOUSE. Unless an adjustment were made for—

Dr. GAYER. And it is a question of how much—you can't get 100 percent of it. And so you can make adjustments for where you want to levy the price and how far upstream you levy the price.

Chairman WHITEHOUSE. And if we wanted to exert pressure on countries like China and India to move off of fossil fuels and to accelerate their transition to clean energy, what U.S. policy would most likely accomplish that?

Dr. GAYER. That was what I was mentioning to your colleague before. I think the carbon tax is both credible. It is supportive of a strong U.S. economy. It helps us transition our energy. It leads to technological innovation, and it helps us both from a diplomatic point of view and also from a technological transfer point of view to get other countries to move in a similar direction.

Chairman WHITEHOUSE. With a robust border adjustment obviously.

Dr. GAYER. Exactly, so, yes, sir. Thank you.

Chairman WHITEHOUSE. Dr. Furchtgott-Roth, welcome back to hearings with me. As you know, you are a frequent flyer here in the halls of Congress, and I think always called by the Republican side and with an astonishing range of expertise.

My review of your testimony is that you have testified on subjects as diverse as the Capital Gains tax, the challenges of the 21st Century workplace, Chief Justice Roberts' record on women's rights, education reform, the Paycheck Fairness Act, residency and right to work issues, medical bankruptcy reform, Samoan fishery

subsidies, the gender pay gap, a balanced budget amendment, that the Affordable Care Act would lead to high unemployment rates, that to help older workers find jobs, we should roll back the Affordable Care Act, eliminate EPA regulations on coal and approve the Keystone XL pipeline, on sequestration, on health insurance, on taxation, on empowerment in the workplace, on job vacancies, on the American Rescue Plan telling employees not to show up for work and on a range of climate related issues. Is that a pretty fair summary of the breadth of your testimony across various Congressional committees?

Ms. FURCHTGOTT-ROTH. Yes, I am fortunate to have been able to write six books and hundreds of articles. I have been chief economist of the Labor Department, the equivalent of chief economist of the Treasury Department and chief of staff of the Council of Economic Advisers. So I have had a lot of—

Chairman WHITEHOUSE. Yeah, that's in your résumé. And you—

Ms. FURCHTGOTT-ROTH. Yes. And—

Chairman WHITEHOUSE [continuing]. Worked before for the American Petroleum Institute is that correct?

Ms. FURCHTGOTT-ROTH. Four years at the American Petroleum Institute, but unfortunately—

Chairman WHITEHOUSE. And you worked at the American Enterprise Institute, is that correct?

Ms. FURCHTGOTT-ROTH. Yes.

Chairman WHITEHOUSE. And then the Hudson Institute?

Ms. FURCHTGOTT-ROTH. I did work for the Hudson Institute.

Chairman WHITEHOUSE. And the Manhattan Institute?

Ms. FURCHTGOTT-ROTH. Yes.

Chairman WHITEHOUSE. And now the Heritage Foundation?

Ms. FURCHTGOTT-ROTH. Yes, yes.

Chairman WHITEHOUSE. And every single one of those groups is funded by the fossil fuel industry, is that not true?

Ms. FURCHTGOTT-ROTH. Well, unfortunately, I don't have the benefit of being able to rely on a family fortune made in the Minnesota gas business or having my spouse's family fortune come from United Gas. And the Heritage Foundation is a club that anyone can join, not just white people. During 2021, it had hundreds of thousands of individual foundation and corporate support as representing every state in the United States.

Chairman WHITEHOUSE. Do you know how much funding it received from the oil and gas baron Koch Industries political operation?

Ms. FURCHTGOTT-ROTH. The top five corporate givers provided the Heritage Foundation with only 1 percent of its 2021 income. Individuals contributed 82 percent, foundations 12 percent, corporations 1 percent, program revenue and other income 5 percent.

Chairman WHITEHOUSE. The answer is that it is over \$5 million from the Koch's various foundations since 1996, from donor's trusts and donor's capital fund, which are the great pass-throughs for the fossil fuel industry to obscure their role. Heritage has received over \$2 million. It has received nearly three-quarters of a million dollars from Exxon since 1998.

In 2019, Heritage reported on its tax return that its various direct mail, telemarketing and fundraising efforts were responsible for 19 of the \$117 million it received. Can you explain where the other \$98 million came from?

Ms. FURCHTGOTT-ROTH. As I have said, we have hundreds of thousands of individual donors. And I have been writing, as you point out, the same things throughout all of my career as a professional economist beginning in 1985, and what I write doesn't depend on where I work.

Chairman WHITEHOUSE. You wrote, for instance, in a Forbes column last year that renewables actually increase global emissions. Do you stand by that comment?

Ms. FURCHTGOTT-ROTH. Yes. Because they are made with coal-fired power plants in China. I did explain that renewables were—the wind turbines and solar panels are made, and batteries are made with coal-fired power plants in China. I did explain that if these were made with emissions-free energy, such as nuclear power, then the benefits to the environment would be much greater. But many environmentalists who are in favor of renewables are against dense emission nuclear power and therefore making these renewables often raises emissions.

Chairman WHITEHOUSE. In addition to stating that renewables actually increase global emissions, have you also agreed that recent data, and I quote here, “calls into question the conclusion that humans are the dominant cause of recent climate change.”

Ms. FURCHTGOTT-ROTH. I am an economist, not a scientist.

Chairman WHITEHOUSE. Well, you wrote that for a Wall Street Journal opinion piece in 2015.

Ms. FURCHTGOTT-ROTH. Yes, well, scientists—

Chairman WHITEHOUSE. Do you stand by it here today in 2023?

Ms. FURCHTGOTT-ROTH. Yes, scientists disagree on the human component of global warming.

Chairman WHITEHOUSE. Okay.

Ms. FURCHTGOTT-ROTH. And in this book, “Unsettled,” by Steve Koonin, who was Undersecretary of Energy under President Obama, and who taught for 30 years at Caltech, and has a Ph.D. in physics from MIT, he says that it is uncertain how much human activity affects global warming. The case is unsettled. And I am no better scientist than he is.

Chairman WHITEHOUSE. Well, thank you very much. It is notable that is the position that the Republican Party intends to stand by. With that, the hearing draws to its conclusion. Anybody wishing to ask a question for the record, try to get that in by noon tomorrow, and one week from that to get any answers. So if you got a QFR, please respond quickly with an answer within a week. And with that, the hearing is concluded. Thank you.

[Whereupon, at 11:36 a.m., Wednesday, May 3, 2023, the hearing was adjourned.]

**Opening Statement of Chairman Sheldon Whitehouse
Senate Committee on the Budget
“Who Pays the Price: The Real Cost of Fossil Fuels”
May 3, 2023**

Ranking Member Grassley, colleagues, welcome to our seventh Committee hearing on the economic and budgetary perils of dependence on fossil fuels. We have heard testimony from non-partisan, knowledgeable industry leaders about the threat climate change poses to entire sectors of our economy: healthcare, insurance, coastal economies, wildfire areas, the carbon bubble leaving fossil fuel assets stranded.

So, what are we, the federal government, doing to protect against these threats? Actually, we are subsidizing the danger.

As we’ll hear today, the United States subsidizes the fossil fuel industry with taxpayer dollars. It’s not just the US: according to the International Energy Agency, fossil fuel handouts hit a global high of \$1 trillion in 2022 – the same year Big Oil pulled in a record \$4 trillion of income.

In the United States, by some estimates taxpayers pay about \$20 billion dollars every year to the fossil fuel industry. What do we get for that? Economists generally agree: not much. To quote conservative economist Gib Metcalf: these subsidies offer “little if any benefit in the form of oil patch jobs, lower prices at the pump, or increased energy security for the country.” The cash subsidy is both big and wrong.

But the really big subsidy is the license to pollute for free. The IMF calls this global free pass an “implicit” fossil fuel subsidy. Economists call it an “unpriced externality.” Behind these benign-sounding phrases is a lot of harm.

Start with harmful effects of local air pollution. Researchers from Harvard found pollutants from oil and gas combustion were responsible for 8.7 million premature deaths annually – the increased mortality rates from heat and air pollution we heard about at last week’s hearing.

Then, growing costs from intensifying disasters: wildfires, floods, droughts, which according to OMB could cost the federal budget \$2 trillion annually and reduce US GDP 3 to 10 percent by the end of the century.

You tally up the harms, and the IMF estimates it at a \$5.4 trillion annual subsidy worldwide. In the United States, it’s \$646 billion – every single year.

Worse, this is almost certainly undercounting the true costs. The London School of Economics reports that studies often underestimate the harm of climate dangers by failing to account for

how hazards can cascade across ecological and economic systems. These cascades can cause irreparable damage to human well-being, to ecosystems, and to the US economy. These are the systemic risks we've heard about from previous witnesses.

And as we will hear from one of our witnesses today, the very act of extracting these dirty fuels has terrible consequences for human health – especially for children. From higher rates of birth defects to childhood leukemia, there's ample evidence that communities around oil and gas extraction sites pay an especially high price.

It's textbook economics that the price of a good should reflect its true cost. The fossil fuel industry violates this rule of market economies. It does so by spending billions of dollars on disinformation, false doubts, climate obstruction, and political dark money. And why not, to protect one of the most lucrative subsidies in human history? This, ladies and gentlemen, is why we can't have nice things like clean air, safe coral reefs, secure coast lines, and affordable clean energy.

Over in the House, MAGA extremists are doubling down on polluter handouts to their big donors, with their Default on America Act that puts the American taxpayer on the hook for climate disaster.

It is not about debts or deficits. It's dirty work for an industry that controls one of the main political parties in this country. Oil and gas extraction represents only about 5 percent of GDP. Farming, manufacturing, food and beverage, insurance, finance, restaurants, retail, housing, healthcare – all represent a larger share of GDP. Clean energy now accounts for more employment than the fossil fuel industry. But for political influence, to protect those massive subsidies, nothing compares to fossil fuel.

It is a fundamental principle of democracy that everyone should get an equal say. But here the rich and the powerful hoard all the benefits for themselves and leave everyone else – often the most vulnerable Americans – to pay the price.

Prepared Statement by Senator Chuck Grassley of Iowa
 Ranking Member, Senate Budget Committee
 Hearing on “Who Pays the Price: The Real Cost of Fossil Fuels”
 Wednesday, May 3, 2023
[VIDEO](#)

Last week’s hearing on climate change and public health was another missed opportunity to discuss our nation’s ailing fiscal health. That same day, House Republicans passed legislation to rein in excessive government spending, lift the debt ceiling and impose meaningful fiscal controls. Meanwhile, Senate Democrats haven’t lifted a finger.

Now, instead of working together to write a responsible budget, we’re here discussing an alleged scheme involving “fossil fuel overlords.” Rather than attacking important American businesses that employ tens of thousands of Americans, we should work together to reduce our unsustainable national debt.

Reaching a consensus will require us to respectfully listen to the opinions of experts whose views may differ from our own. No one learns anything sitting in an echo-chamber. This is one reason why I’ve invited witnesses with a variety of views during this series of climate change hearings.

Sometimes I’ve disagreed with a witness I invited on this or that, but I value their opinion. Today is no different. Ms. Furchtgott-Roth and I don’t see eye-to-eye on all energy matters, particularly when it comes to renewable fuels and wind.

However, we do agree oil and gas are critical to lowering energy costs, protecting our national security and reducing CO2 emissions. We also agree that President Biden’s war on fossil fuels has been disastrous for our economy and terrible for consumers.

I believe in an all-of-the-above energy strategy. Oil, gas, biofuels, wind -- we need them all for national security and for economic success. President Biden, on the other hand, believes in an all-of-his-preferred-and-none-of-the-rest strategy.

Poor policy decisions have consequences and, as a result, we have seen energy prices rise substantially across the board. This is why the two leading topics of concern that I’ve heard from Iowans during the Biden Administration have been inflation and the price of gasoline. The President can deflect blame all he wants, but the rise in the price of gasoline has been a direct consequence of his administration’s actions.

Candidate Biden vowed to end fossil fuels during his campaign.

On his first day in office, he decided to shut down the Keystone Pipeline, stifling our ongoing energy independence and killing thousands of jobs.

Also, in January of 2021, he issued an executive order pausing new oil and gas leases on public lands and federal waters.

A barrage of his destructive environmental regulations followed, which continue to prevent the construction of much needed fossil fuel infrastructure.

Last month, President Biden issued his first veto to uphold his 401(k) investment rule. This rule will hurt everyday Americans' investments just to further liberal environmental, social and corporate governance (ESG) goals.

And just a few weeks later, President Biden's EPA announced its plan to mandate two-thirds of all new vehicles to be electric by 2032. These are the same EVs most Americans can't afford, and don't want, but Democrats subsidized them as part of their misnamed Inflation Reduction Act, a green energy boondoggle whose price tag is ballooning.

The Joint Committee on Taxation recently told us its tax subsidies will cost \$300 billion more than originally advertised. And its cost could rise further once we see updated scores of its EV subsidies.

The average price of an electric vehicle according to Kelley Blue Book is \$65,000, roughly the equivalent of Iowa's median household income. But, even if half of Americans could afford an EV, which they can't, an even bigger problem exists. We have neither the load capacity nor the materials to achieve President Biden's energy overhaul.

Large swaths of the United States electrical grid are at risk for shortfalls this summer. Grid reliability is a significant concern already, let alone the concern over the grid handling the load of President Biden's electric vehicle fantasy.

Moreover, we all know that the Communist Party of China has a monopoly on the critical mineral mining and refining required to build EV batteries. They're forcing the Uyghurs into slavery to bolster their supply chain. That's all being supported by the Biden Administration. Meanwhile, Democrats and environmentalists won't allow us to permit mining projects here in the United States.

Not only is this administration pushing for policies that drive up the price of gasoline, but their policies would make us even more dependent on a supply-chain that runs directly through China.

Ms. Furchtgott-Roth, welcome. Given your years of experience as an economist on the President's Council on Economic Advisors, I look forward to having a substantive discussion about what we should be doing to reduce energy costs and strengthen our fiscal position. And I welcome all the witnesses.





STATEMENT OF TED GAYER

PRESIDENT, NISKANEN CENTER

TESTIMONY FOR THE UNITED STATES SENATE COMMITTEE ON THE BUDGET

FULL COMMITTEE HEARING ON:

“Who Pays the Price: The Real Cost of Fossil Fuels”

May 3, 2023

Chairman Whitehouse, Ranking Member Grassley, and Members of the Committee, thank you for inviting me to testify on fossil fuel subsidies. My name is Ted Gayer, and I’m the President of the Niskanen Center. I am an economist who served in the Department of Treasury and the Council of Economic Advisers in the George W. Bush Administration. I have also worked at the Brookings Institution, the American Enterprise Institute, Georgetown University, and the Public Policy Institute of California.

In my testimony, I will address three points. First, instead of providing subsidies to fossil fuels, our tax code should promote market-friendly incentives that factor in the external costs of energy use. Second, the size of existing fossil fuel subsidies depends on various factors, such as whether one is focusing on their overall size or their size compared to subsidies granted to other industries. And third, since fossil fuel subsidies are relatively small, their elimination would have a minimal impact on both fossil fuel production and prices.

Historically, federal energy tax policies have sought to boost domestic energy production, generate tax revenue, and promote environmental quality. These goals are often in conflict, such as when we impose a gas guzzler tax to reduce fuel consumption while we simultaneously subsidize oil production to increase domestic output. Energy policy should instead account for the sizable external cost of energy consumption, such as the costs associated with climate change and particulate pollution, by implementing a carbon tax that encourages consumers and producers to reduce emissions through market incentives. However, current tax provisions include several fossil fuel subsidies that contradict this goal.

Most fossil fuel subsidies exist in the tax code. Under current law, a handful of tax provisions provide benefits to oil and natural gas production in the United States. These provisions generally reduce the tax burden on oil and natural gas companies in the United States. They either directly reduce tax liability by providing tax credits or indirectly by reducing taxable income.

Most fossil fuel subsidies are implemented as tax expenditures in our tax code. Quantifying the precise value of these tax expenditures is challenging and depends on the baseline tax definition. The Joint Committee on Taxation (JCT) deems a tax provision a tax expenditure if it deviates from a baseline income tax.¹ If one instead considers a consumption tax as the baseline tax system, then many current provisions would not qualify as tax expenditures. Furthermore, several fossil fuel tax expenditures apply to other industries within and outside the energy sector, so their magnitude depends on whether one is focusing on their overall size or their size compared to subsidies granted to other industries.

It is also worth noting that the U.S. Treasury Department maintains estimates of tax expenditures. However, their list includes provisions not included in the JCT list, and some provisions included in the JCT list are not in the Treasury list.²

Fossil fuel tax provisions included in most lists fall into four general categories: cost recovery, the treatment of inventories, the treatment of foreign profits, and tax credits.

The Tax Treatment of Cost Recovery

Cost recovery concerns the rules by which businesses can recover the costs of their capital assets through tax deductions over a specified period. For fossil fuel businesses, these include provisions such as expensing of intangible drilling costs and expensing of tertiary injectants.

A large portion of fossil fuel tax provisions are cost recovery provisions. As such, they are deductions oil and natural gas companies receive for capital investments. They are considered tax expenditures because they are more accelerated than what would occur under a typical baseline income tax, according to the JCT. Table 1 provides 5-year estimates by JCT of the budgetary costs of these tax provisions.

Table 1. Fossil Fuel Cost Recovery Tax Provisions

Provision	5-Year Budgetary Cost 2022-26, <i>billions</i>
Expensing of intangible drilling costs (IDCs)	\$2.2*
Expensing of oil and gas exploration and development costs	
Expensing of tertiary injectants	De minimis
Amortization of geological and geophysical expenditures associated with oil and gas exploration	\$0.6
Accelerated amortization of air pollution control equipment	\$2.3
Excess of percentage over cost depletion for oil and gas	\$2.7
Seven-year MACRS Alaska natural gas pipeline	De minimis
15-year MACRS for natural gas distribution line	\$0.3

Source: “[Estimates of Federal Tax Expenditures for Fiscal Year 2022-2026](#),” Joint Committee on Taxation, 28, 36.

¹ “Estimates of Federal Tax Expenditures for Fiscal Years 2022-2026,” Joint Committee on Taxation, JCX-22-22 (U.S. Congress, Dec. 22, 2022), <https://www.jct.gov/publications/2022/jcx-22-22>, p. 3-4.

² “[Estimates of Federal Tax Expenditures for Fiscal Years 2022-2026](#),” Joint Committee on Taxation, p. 20.

Note: A de minimis tax expenditure is less than \$50 million during FY2022-FY2026; these are not listed in JCT's tax expenditure table but noted separately in the report.

**JCT included expensing of intangible drilling costs as part of the expensing of oil and gas exploration and development costs.*

Again, these JCT estimates are for total tax expenditures, not relative to the tax expenditures received by other companies. Current law allows companies in other industries to accelerate their cost recovery. For example, a corporation that invests in computer equipment can immediately deduct 80 percent of the cost up front. Meanwhile, an oil company can immediately deduct tertiary injectants investment.³ Both companies get accelerated depreciation, but the oil company gets a slightly larger benefit.

It is also worth noting that not all oil and natural gas companies can receive the full benefit of these provisions.⁴ For example, nonintegrated oil and gas producers can fully expense their intangible drilling costs (IDCs). In contrast, integrated producers can fully expense 70% of their IDCs and recover the remaining 30% over five years.⁵

According to the JCT, cost recovery provisions amount to approximately \$8.1 billion over fiscal year 2022-2026 in tax expenditures for fossil fuel companies, which is approximately \$1.6 billion annually.

The Tax Treatment of Inventories

Under current law, businesses with inventories cannot immediately deduct their costs until they are sold. Consistent with Generally Acceptable Accounting Practices, corporations can make assumptions about what inventories are sold in what order. The two most common inventory valuation methods are First-in, First-out (FIFO) and Last-in, First-out (LIFO).

Under FIFO, a corporation can assume that the cost of the first inventory purchased or produced is deducted against the sale of an inventory. In contrast, a corporation using LIFO can deduct the costs of producing the last unit of an inventory. If costs of inventory production rise over time, this method reduces the business's tax burden relative to deducting the costs associated with the first unit of inventory. One could draw the analogy between LIFO and accelerated depreciation of capital assets, which does a similar thing for capital assets. However, if prices are expected to fall, LIFO is less generous than FIFO.⁶ LIFO is a tax expenditure, and is considered as such by JCT, but it is available to any corporation. JCT does not break out the costs specific to LIFO available to fossil fuel companies.

³ Molly F. Sherlock, "Energy Tax Provisions: Overview and Budgetary Cost," Congressional Research Service report R46865 (Aug. 34, 2021), <https://crsreports.congress.gov/product/pdf/R/R46865>, p. 13.

⁴ Kevin A. Hassett and Alan D. Viard, "Big Oil, Targeted Taxes, and the Rule of Law," *Tax Notes* 135, no. 2 (April 9, 2012), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2218386.

⁵ CRS, "Energy Tax Provisions," p. 13; Hassett and Viard, "Big Oil," p. 220.

⁶ Kyle Pomerleau, "The Tax Treatment of Inventories and the Economic and Budgetary Impact of LIFO Repeal," *Tax Foundation Fiscal Fact*, no. 501 (Tax Foundation, February 2016), https://files.taxfoundation.org/legacy/docs/TaxFoundation-FF501.pdf?_gl=1*8j44rc*_ga*ODM5MTU2NjE3LjE2NTU0MDY5NTU.*_ga_Fp7KWDV08V*MTY4MTc1NjI5OS40NS4xLjE2ODE3NTYzMTEuNDguMC4w; Alan D. Viard, "Why LIFO Repeal is Not the Way to Go," *Tax Notes* 113, no. 6 (November 6, 2006), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2218442.

The Tax Treatment of Foreign Profits

The Tax Cuts and Jobs Act (TCJA) included significant reforms to the tax treatment of foreign profits of multinational corporations. It replaced the previous system that subjected worldwide profits to U.S. taxation with a deferral for active foreign profits with a territorial or source-based tax system that only applies U.S. tax on U.S.-source profits. To dissuade multinationals from shifting highly mobile income out of the United States, the law included provisions to continue taxing certain types of profit on a global basis, albeit below the standard corporate tax rate.⁷⁸

The two most important components of the new provisions are two new definitions of income: Global Intangible Low-Taxed Income (GILTI) and Foreign Derived Intangible Income (FDII). GILTI creates a 13.125 percent minimum tax on the returns to intangible income in foreign jurisdictions. FDII is a mirror image of GILTI that creates a special lower rate of 13.125 percent on intellectual property products located in the United States and used to serve foreign markets.⁹

GILTI excludes what is called “FOGEI” or foreign oil and gas extraction income. The JCT considers any tax exemption on foreign profits (less a credit for foreign taxes paid) to be a tax expenditure. JCT’s baseline tax code would tax the worldwide profits of U.S.-based multinational corporations. As such, FOGEI would be considered a tax expenditure because it exempts a portion of foreign profits from immediate taxation in the United States. However, the JCT does not break out the cost of this provision.

If one considers a corporate tax based on worldwide profits of U.S. firms the baseline tax system, then FOGEI should be taxed along with all other foreign profits that are currently exempt. However, under the U.S. current source-based tax system, all foreign profits would be exempt from U.S. taxation. In the context of GILTI, FOGEI is neither intangible nor mobile, so there is a policy justification for its exemption.

The second major provision that impacts foreign profits of oil and natural gas companies is “dual capacity” regulations. These regulations set out rules that govern what payments oil and gas companies can count as “foreign income tax” for purposes of getting a U.S. credit. Generally, companies can only

⁷ Kyle Pomerleau, “Biden’s Reforms to the Tax Treatment of US Multinational Corporations: The Knowns and Unknowns,” *AEI Economic Perspectives* (American Enterprise Institute, July 2021), <https://www.aei.org/wp-content/uploads/2021/07/Bidens-Reforms-to-the-Tax-Treatment-of-US-Multinational-Corporations.pdf?x91208> <https://taxfoundation.org/multinational-tax/>

⁸ Kyle Pomerleau, “A Hybrid Approach: The Treatment of Foreign Profits under the Tax Cuts and Jobs Act,” *Tax Foundation Fiscal Fact*, no. 586 (Tax Foundation, May 2018), https://files.taxfoundation.org/20180502205047/Tax-Foundation-FF586.pdf?_gl=1*1m8hwcz*_ga*ODM5MTU2NjE3LjE2NTU0MDY5NTU.*_ga_FP7KWV08V*MTY4MTC1NjI5OS40NS4xLjE2ODE3NTg3NTkuNjAuMC4w.

⁹ Kyle Pomerleau, “Biden’s Reforms to the Tax Treatment of US Multinational Corporations: The Knowns and Unknowns,” *AEI Economic Perspectives* (American Enterprise Institute, July 2021), <https://www.aei.org/wp-content/uploads/2021/07/Bidens-Reforms-to-the-Tax-Treatment-of-US-Multinational-Corporations.pdf?x91208>.

consider income taxes creditable against U.S. tax liability on foreign profits. Other payments, such as royalties cannot be credited and are merely deductible against taxable income.¹⁰

The Biden Administration wants these rules tightened to classify more payments made to foreign governments as royalties.¹¹ This would raise the tax burden on foreign profits because deductions are less valuable than a credit. Current rules, however, allow for some flexibility. Some countries tend to blur the line between income tax payments and royalties and current rules allow companies to argue in court the proper treatment. Dual capacity regulations are not considered a tax expenditure by JCT.

Tax Credits

Under current law, oil and natural gas companies can receive several (generally small) tax credits. For example, firms can claim a credit for producing oil and gas from marginal wells when oil and gas prices fall below certain benchmarks.¹²

With some exceptions, credits are generally inconsistent with JCT's benchmark tax code or under alternative tax systems like a consumption tax. These are more clearly subsidies than other provisions. Still, these provisions are very small (as shown in Table 2).

Table 2. Tax Credits

Provision	5-Year Budgetary Cost 2022-26, Billions
Credit for enhanced oil recovery costs	De minimis
Credit for producing oil and gas from marginal wells	De minimis
Credits for investments in Clean Coal Facilities	\$0.8
Production credit for refined coal	\$0.1
Production credit for Indian coal	\$0.1

Source: "[Estimates of Federal Tax Expenditures for Fiscal Year 2022-2026](#)," Joint Committee on Taxation, 28, 35.

Note: A de minimis tax expenditure is less than \$50 million during FY2022-FY2026; these are not listed in JCT's tax expenditure table but noted separately in the report.

Other Provisions: Tax Exemptions, Deferrals, and Lower Rates

This category of tax benefits provides either lower rates for certain types of income, exempts certain types of income, or allows for deferral of taxation, as shown in Table 3. In some cases, these provisions are more generous to oil and gas companies than to other industries. For example, oil and gas

¹⁰ KPMG, "Tax Provisions in Biden Administration's FY 2022 Budget Proposals," June 18, 2021, <https://assets.kpmg.com/content/dam/kpmg/us/pdf/2021/06/tnf-biden-fy-2022-budget-energy-june18-2021.pdf>.

¹¹ Alex Muresianu and William McBride, "A Guide to the Fossil Fuel Provisions of the Biden Budget," Tax Foundation, Sept. 2, 2021, <https://taxfoundation.org/biden-fossil-fuel-tax>; White House Office of Management and Budget, *Budget of the U.S. Government: Fiscal Year 2024*, 155.

¹² CRS, "[Energy Tax Provisions](#),"

investments are exempt from the general rule that “passive losses,”—those from investments a taxpayer is not directly managing—cannot be used to offset active income (wages, salaries, active business income). However, this is not considered a tax expenditure by the JCT because loss deductions are a component of JCT’s baseline income tax. (The U.S. Treasury does consider this a tax expenditure).¹³

Table 3. Other Provisions

Provision	5-Year Budgetary Cost 2022-26, Billions
Capital gains treatment for royalties	N/A
Exceptions for publicly-traded partnership with qualified income derived from certain energy-related activities	\$2.7
Oil Spill Liability Trust Fund and Superfund excise tax exemption for crude oil derived from bitumen and kerogen-rich rock	N/A
Exception to passive loss limitations provided to working interests in oil and natural gas properties	N/A

Source: “[Estimates of Federal Tax Expenditures for Fiscal Year 2022-2026](#),” Joint Committee on Taxation, 24, 36.

Note: N/A denotes that a tax provision/rule is either not considered as a tax expenditure by JCT, or that an estimate is not available.

In total, JCT estimates the value of the value of fossil fuel tax expenditures at approximately \$11.8 billion for the five-year period of 2022-2026. The tax expenditures denoted as de minimis and the ones not quantified are not included in this estimate.

Given their relatively small magnitude, fossil fuel subsidies are unlikely to significantly increase production in the United States. The Congressional Budget Office estimates that fossil fuel tax subsidies led to a minimal impact of 0.4 to 0.8 percent more domestic oil production.¹⁴ The U.S. Treasury and other academic studies find similarly small effects of fossil fuel tax subsidies on domestic production.¹⁵ These small effects mean they do not achieve the goal of insulating domestic prices from foreign supply disruptions, particularly since prices are determined in the global market.

In conclusion, regardless of their magnitude, fossil fuel subsidies hinder efforts to reduce carbon emissions. A better approach is a border-adjusted carbon tax to create market incentives to account for

¹³ “[Estimates of Federal Tax Expenditures for Fiscal Years 2022-2026](#),” Joint Committee on Taxation, p. 22.

¹⁴ Congressional Budget Office, “Federal Support for the Development, Production, and Use of Fuels and Energy Technologies,” November 2015, p. 12, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/50980-energy-support-onecol-3.pdf>.

¹⁵ Gilbert E. Metcalf, “The Impact of Removing Tax Preferences for U.S. Oil and Natural Gas Production: Measuring Tax Subsidies by an Equivalent Price Impact Approach,” NBER Working Paper 22537 (National Bureau of Economic Research, August 2016), https://www.nber.org/system/files/working_papers/w22537/w22537.pdf; Maura Allaire and Stephen Brown, “Eliminating Subsidies for Fossil Fuel Production: Implications for U.S. Oil and Natural Gas Markets,” Issue Brief 09-10 (Resources for the Future, December 2009), <https://media.rff.org/documents/RFF-IB-09-10.pdf>, p. 8; U.S. Treasury Department, “Statement of Alan B. Krueger Assistant Secretary for Economic Policy and Chief Economist, US Department of Treasury Subcommittee on Energy, Natural Resources, and Infrastructure,” Sept. 10, 2009.

the costs of energy use. Such taxes make use of market forces, which is preferable to subsidies that require government picking winners and losers.¹⁶

Mr. Chairman, Ranking Member Grassley, thank you once more for the opportunity to speak today. I look forward to your questions.

¹⁶ Ted Gayer, "Linking Climate Policy to Fiscal and Environmental Reform," Brookings Institution, 2012, https://www.brookings.edu/wp-content/uploads/2016/06/0302_climate_policy_gayer.pdf; Ted Gayer and Phillip Swagel, "Pro-Growth Carbon Tax: A Catalyst for Regulatory and Tax Reform," (Alliance for Market Solutions, June 1, 2016), <https://amsresearch.org/wp-content/uploads/2019/03/Pro-Growth-Carbon-Tax-A-Catalyst-for-Regulatory-and-Tax-Reform.pdf>; Shuting Pomerleau, "Border Adjustments in a Carbon Tax," (Niskanen Center, July 2020), <https://www.niskanencenter.org/wp-content/uploads/2020/07/Border-Adjustments-in-a-Carbon-Tax.pdf>.

WRITTEN STATEMENT OF
NICOLE DEZIEL, PHD, MHS
to the COMMITTEE ON THE BUDGET
of the UNITED STATES SENATE

Hearing on “*Who Pays the Price: The Real Cost of Fossil Fuels*”
May 3, 2023

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Chairman Whitehouse, Ranking Member Grassley, and distinguished Members of the Senate Budget Committee, it is an honor to have the opportunity to participate in this important hearing.

My name is Nicole Deziel, and I am an Associate Professor at the Yale School of Public Health in the Department of Environmental Health Sciences. My testimony will address the human health impacts of oil and gas development. These remarks are informed by a strong body of evidence including my own 9 years of research and more than 25 publications on the exposures, health, and environmental justice impacts of oil and gas development (OGD) to communities living near oil and gas wells across multiple states.

I have five key points to share.

1. Living near oil and gas development has been associated with a range of health problems, with the greatest evidence of risks reported for children.

The growth in the oil and gas development industry has placed millions of United States (US) residents in the path of multiple hazards associated with oil and gas operations. In 2020, nearly 1,000,000 oil and gas wells were in operation (1), and a 2017 analysis estimated that 17.6 million US residents lived within 1600 m (1 mile) of an active oil or gas well (2).

Oil and gas development has been associated with a range of health problems in nearby populations, with the greatest risks reported for children. The weight of the scientific evidence indicates that the risk of various adverse health outcomes (e.g., adverse birth outcomes, respiratory outcomes) increases with a greater proximity and density of oil and gas wells around people’s homes.

Approximately 50 peer-reviewed epidemiologic studies, including those from my own research group, provide evidence of a relationship between oil and gas development and human health risks (3-6) (Table 1). These studies report associations between residential proximity to, or density of, oil and gas wells

and increased adverse pregnancy outcomes, childhood cancer incidence, hospitalizations, asthma exacerbations, and mental health issues (Table 1).

The strongest evidence is for health problems to newborn babies, such as birth defects, preterm birth, and low birthweight. Such associations have been observed across numerous states including Pennsylvania, Colorado, Texas, Oklahoma, and Ohio (5-7). The fact that there is consistency of results across multiple studies that were conducted using different methodologies, in different locations, during different time periods, and among diverse populations provides additional confidence in the body of research.

Additional studies in pediatric populations demonstrate a higher burden of childhood leukemia in communities exposed to oil and gas extraction (8, 9). For example, in our recent study conducted in Pennsylvania and looking at unconventional oil and gas development (UOGD; also referred to as shale gas development or fracking), we found that children ages 2-7 living near unconventional oil and gas at birth were two to three times more likely to be diagnosed with acute lymphoblastic leukemia than unexposed children, after accounting for other factors that can influence cancer risk.

Respiratory health outcomes are another well-studied health outcome, with at least nine peer-reviewed studies published to date from California, Pennsylvania, and Texas. These studies reported associations between oil and gas development and asthma exacerbations, asthma hospitalizations, and respiratory symptoms (10-17).

The Bradford Hill Criteria is a framework used to evaluate the strength of epidemiological evidence between an exposure and observed outcome. These criteria are widely used in the field of epidemiology and public health practice to guide decision-making. Table 2 shows how the body of evidence on the relationship between OGD and perinatal health outcomes meets the criteria and strongly supports an association between close geographic proximity to OGD and adverse perinatal outcomes.

Table 1. Health studies of oil and gas development. Adapted from Deziel 2022.				
Oil and gas exposure assessment method	Study endpoints			
	Adverse perinatal outcomes (n=25)	Hospitalizations, asthma, or cardiovascular diseases (n=13)	Cancer (n=4)	Other health outcomes (n=9)
Aggregate Proximity-based Metrics and Models				
Presence or number of wells or permits per zip code, county, or other geographic metric	Ma 2016 (18) Tran 2021 (19) Busby 2017 (20) Tang 2021 (21) Tran 2020 (22) Apergis 2019 (23) Hill 2018 (24)	Jemielita (25) 2015 Willis 2018 (14) Denham 2019 (26) Denham 2021 (27) Willis 2020 (28) Peng 2018 (11) Johnston 2021 (15) Trickey 2023 (17)	Fryzek 2013 (29) Finkel 2016 (30)	Deziel 2018 (31) Beleche 2018 (32) Komarek 2017 (33) Johnson 2020 (34)
Distance to UOG well	Currie 2017 (35) Willis 2021 (36) Hill 2022 (37)	Koehler 2018 (10)		Weisner 2023 (38)
Inverse distance weighted well count	Stacy 2015 (39) McKenzie 2014 (40) Whitworth 2018 (41) Whitworth 2017 (42) Janitz 2019 (43) Caron-Beaudoin 2021 (44) Willis 2023 (45) Gaughan 2023 (7)	Koehler 2018 (10)	McKenzie 2017 (8)	
Inverse distance-squared weighted	Gonzalez 2020 (46)			
Activity-based metric	Casey 2016 (47) Casey 2019 (48) Tran 2020 (22)	McAlexander 2020 (49) Koehler 2018 (10) Rasmussen 2016 (13) Willis 2020 (28)		Tustin 2016 (50) Casey 2018 (51)
Pathway-Specific and Other Models and Metrics				
Water pathway	Gaughan 2023 (7)		Clark 2023 (7)	
Air pathway	McKenzie 2019 (52)	McKenzie 2019 (53)		
Flaring	Cushing 2020 (54)			
Manmade earthquakes	Han 2023 (55)			Elser 2023 (56)

Table 2. Application of the Bradford Hill Criteria for Causation to the peer-reviewed epidemiological literature on oil and gas development and perinatal health outcomes. (Adapted from Shonkoff, Seth BC, et al. "RE: Response to CalGEM Questions for the California Oil and Gas Public Health Rulemaking Scientific Advisory Panel." (57))		
Criteria	Description of Criteria	Perinatal Health Studies
Strength of Association	Environmental studies commonly report modest effects sizes (i.e., relative to active tobacco smoking or alcohol consumption). A small magnitude of association can support a causal relationship, a larger association may be more convincing.	Reported effect sizes are in ranges similar to other well-established environmental reproductive and developmental hazards, such as PM _{2.5} . Some studies have found stronger effect estimates for OGD exposures among socially marginalized groups.
Consistency	Consistent findings observed by different persons in different places with different samples strengthens the likelihood of an effect.	Adverse birth outcomes have been observed in multiple studies using multiple methods in different populations at different times and locations (e.g., California, Pennsylvania, Colorado, Texas). While there is some variation in findings by specific perinatal outcomes, the overall body of evidence is highly consistent in supporting the association between OGD and adverse perinatal outcomes.
Specificity	Causation is likely if there is no other likely explanation.	All peer-reviewed birth outcome studies included in our review controlled for other potential confounders by (i) accounting or adjusting for other individual-level or area-level factors (e.g., other air pollution sources, neighborhood socioeconomic status) in the analysis. Other studies applied statistical modeling approaches such as difference-in-difference that accounts for temporal and spatial trends that may confound observed effects.
Temporality	Exposure precedes the disease.	Most birth outcomes studies have proper temporal alignment between exposure and outcome and use a retrospective cohort, case control or other study design that allows retroactive assessment of exposures to OGD occurring before the onset of disease. They do not consider exposure that occurred at the time of disease or oil and gas wells drilled after the disease.

Biological Gradient (Dose-Response)	Greater exposure leads to a greater likelihood of the outcome.	Some studies have found dose-response relationships based on oil and gas production volume categories or metrics of inverse distance weighting and/or oil and gas well density in California and elsewhere.
Plausibility	The exposure pathway and biological mechanism is plausible based on other knowledge.	Individual health-damaging chemical pollutants are well-understood to be emitted from OGD (e.g., PM _{2.5} , benzene) and established as contributing to increased risk for the same adverse perinatal outcomes observed in the epidemiology studies. Stressors associated with OGD (e.g., psychosocial stress) can also contribute to increased adverse perinatal outcomes.
Coherence	Causal inference is possible only if the literature or substantive knowledge supports this conclusion.	In particular, the body of peer-reviewed literature is converging towards singular directions for adverse perinatal outcomes.
Experiment	Causation is a valid conclusion if researchers have seen observed associations in prior experimental studies.	N/A- Human population-based experimental studies are not available due to ethical issues.
Analogy	For similar programs operating, similar results can be expected to bolster the causal inference concluded.	Pollutants well known to be emitted during OGD including benzene, toluene and 1,3 butadiene are listed as reproductive or developmental toxicants. EPA's current Integrated Science Assessments of particulate matter and tropospheric ozone conclude that the evidence is suggestive of, but is not sufficient to infer, a causative relationship between birth outcomes, including preterm birth and low birth weight, and PM _{2.5} and long-term ozone exposures. Additionally, increased stress during pregnancy can alter fetal growth and length of gestation.

2. A growing number of environmental monitoring studies have concluded that oil and gas development contributes to air pollution, noise, odors, water contamination, radioactive releases, seismic activity, and increased traffic.

Chemical Contaminants in Water

With more than 9 million people in the US relying on drinking-water sources located within 1.6 km (1 mile) from an unconventional oil and gas well (9), water contamination has been a major community concern (15, 16). Hundreds of chemicals have been reportedly used in injection water or detected in wastewater, including known and suspected developmental and reproductive toxicants and carcinogens, such as metals, volatile organic compounds, polycyclic aromatic hydrocarbons, phthalates, and per- and poly-fluoroalkyl substances (PFAS) (58-65). Water contamination may occur due to surface spills of fracturing or wastewater fluids, release of improperly treated wastewater, structural failures, and well leaks (65-72). Groundwater monitoring studies conducted thus far do not support widespread contamination (73-76). However, groundwater and surface water impairments, spills, and violations have been documented across multiple states (66, 68, 77-82).

Air Pollutants

UOGD generates air pollutants from various sources, including well and road construction; use of diesel-powered construction, drilling, and transportation equipment and vehicles; dust generation during drilling; intentional flaring of natural gas; and volatilization of wastewater constituents (83-85). Emission sources have different temporal profiles and may be continuous over varying time frames (e.g., diesel equipment, leaks) or be intermittent (e.g., flaring, venting). They may also occur at the well pad or off-site from transportation or associated UOG infrastructure (10). Studies of airborne emissions or concentrations have identified several pollutants associated with UOGD activities, including carcinogens (e.g., diesel particulate matter, polycyclic aromatic hydrocarbons), and reproductive and/or developmental toxicants (e.g., ethylbenzene, toluene) (59, 83, 86-90).

Radiation, Radioactivity, and Radon

Technologically enhanced naturally occurring radioactive compounds (TENORMS) have been detected in a variety of wastes generated by unconventional oil and gas development, including produced water (91-93), lateral drill cuttings (93), and impoundment sediments (94), and co-occur with sludges and mineral scales that accumulate inside unconventional oil and gas development equipment (91). TENORMS have also been found in streambed sediments next to facilities managing unconventional oil and gas development wastewaters (95). Additionally, higher indoor radon levels were observed in homes with more or closer oil and gas wells compared to those with fewer or farther oil and gas wells (96, 97). Health effects of radiation exposure include adult and childhood cancers (58), impaired lung function (98), increased blood pressure (99), and oxidative stress (100).

Sensory Stressors

Sensory stressors include noise, artificial light at night, and odors (3, 101-103). Noise pollution can activate the sympathetic nervous system; lead to annoyance, stress, and sleep disturbance; and potentially contribute to cardiovascular disease and adverse birth outcomes (3, 104). Odorous compounds can reflect mixtures of volatile organic or sulfuric compounds, which have neurotoxic and

respiratory effects, and can also trigger annoyance, concern, and anxiety at levels below established toxicity thresholds (105, 106).

Greenhouse Gases

Methane, a potent greenhouse gas, is emitted to the air throughout UOGD from leaks and intentional releases (e.g., venting) (107). Although methane is not directly toxic to nearby communities, except at very high levels in tap water, at which point it poses a flammability danger, it impacts future health risks through its role in climate change.

3. Exposures and health risks are not distributed equally across nearby communities, with disproportionate impacts observed for some disadvantaged populations.

Certain subgroups of the population, such as communities of color or lower income, often bear a disproportionate burden of exposure to environmental pollution, can lack adequate access to regulatory and reporting information, and health risks may be exacerbated by the co-occurrence of socioeconomic stressors. In Texas, unconventional oil and gas wastewater disposal wells were more likely to be sited in communities of color (108). In our study in Ohio, we found that oil and gas waste wells were disproportionately sited in areas of lower income (109). In Texas, Hispanic populations were more likely to be exposed to flaring, a practice of burning excess gas yielding light at night, noise, and noxious odors (110). In another study from our group, we found that communities with high proportions of lower-income and elderly people in rural areas are the most vulnerable to groundwater pollution from hydraulic fracturing in the Appalachian Basin (OH, PA, WV) (111). A recent California study found that Black, Hispanic, and socioeconomically marginalized people had disproportionately higher exposure to oil and gas wells over three time periods (112).

4. The limited monitoring data, particularly in rural areas where substantial drilling occurs, are challenges to fully understanding hazards and risks.

I will take the example of water contamination from oil and gas. Potential water contamination events include surface spills of fracturing or wastewater fluids, release of improperly treated wastewater, and leaks in well infrastructure (113). The fracturing fluids and wastewater used or produced by oil and gas development may contain toxic, radioactive, endocrine-disrupting, and/or carcinogenic chemicals (58, 59).

An estimated 1-4% of UOG wells have reported spills (77, 78) and approximately 20% have a non-administrative violation (e.g., a pollution incident, well construction issue) (66). While unconventional oil and gas studies have not found evidence of widespread water contamination. (9, 75, 76, 114), specific instances of groundwater and surface water impairments have been identified (68, 79, 115).

Water monitoring data near drilling sites are limited, posing a challenge to the assessment of potential water-related impacts. In the US, oil and gas development often occurs in rural areas where homes are served by private domestic drinking water wells, which are not subject to federal regulations and

monitoring (116). Water testing can be cost-prohibitive, and in our studies, many residents had never had their drinking water tested.

5. Multiple, complementary strategies would serve to more adequately address oil and gas hazards and better protect community health.

One of the most commonly-used policy protections for communities near oil and gas wells are setbacks, the allowable distance between an oil and gas well and a sensitive receptor such as homes, schools, and other places where people live, work, and play. The utility of setbacks is based on the premise that the hazards associated with oil and gas operations attenuate with distance. Because hazards dissipate at different functions of distance, it is challenging to establish a universal setback that optimally addresses all hazards. Furthermore, setbacks also do not prevent the release of methane or other greenhouse gases that contribute to climate change (117). Finally, increasing distance between OGD activities and human residential communities could place OGD infrastructure closer to wildlife communities, thereby shifting the burden to ecological rather than human health impacts (118). To date, 23 states have adopted or are considering setbacks that vary widely and range from 100 ft (e.g., Arkansas and New York) to 3200 ft (California) (119).

From a public health perspective, the most effective strategy for protecting communities from the hazards of OGD would be to reduce development of new oil and gas wells and phase out existing oil and gas activities and infrastructure with proper well plugging and environmental remediation because the local hazards and regional hazards such as greenhouse gases would be completely removed (117). Although most effective at protecting health, complete elimination represents a systemic shift from the status quo with substantial political, socioeconomic, and logistical ramifications. Despite these challenges, examples of elimination are occurring throughout the US. Unconventional oil and gas development has been eliminated in Vermont, Maryland, New York, and Washington, states. The Delaware River Basin (DRB) Commission prohibited hydraulic fracturing in the DRB region, which covers parts of New York, Pennsylvania, New Jersey and Delaware. Some municipalities are moving towards complete OGD elimination, including Los Angeles, which has approved a ban of all new conventional and unconventional oil and gas wells and a phase-out of existing wells.

Figure 1 below illustrates the concept of a Hierarchy of Controls. The concept of hierarchy of controls originated from the fields of occupational health to prioritize mitigation strategies from the most to the least effective at reducing hazards to workers. This figure represents an application of this framework to the nearby communities. At the top is the most health protective strategy: to stop drilling and developing new wells, phase out existing OGD activities and associated infrastructure, and properly plug remediate legacy wells and ancillary infrastructure. Other strategies include setbacks and engineering controls.

In conclusion, there is clear evidence for health hazards from oil and gas development, which are not adequately addressed by current policies.

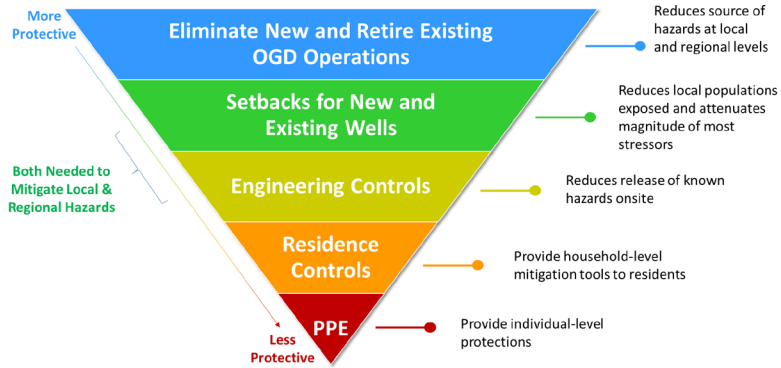


Figure 1. Hierarchy of controls to reduce public health harms from oil and gas development (OGD) activities. PPE: personal protective equipment (Adapted from Deziel et al. 2022) (117).

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Who Pays the Price: The Real Cost of President Biden's Energy Agenda

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Who Pays the Price: The Real Cost of President Biden's Energy Agenda

My name is Diana Furchtgott-Roth. I am the director of the Center for Energy, Climate, and Environment at The Heritage Foundation. The views I express in this testimony are my own and should not be construed as representing any official position of The Heritage Foundation.

Chairman Whitehouse, Ranking Member Grassley, Members of the Committee, I am honored to be invited to testify before you today on the subject of "Who Pays the Price: The Real Cost of President Biden's Energy Agenda."

In addition to my role at The Heritage Foundation, I am also an adjunct professor of economics at George Washington University. My professional training is in economics. From 2019 to 2021 I was deputy assistant secretary for research and technology at the U.S. Department of Transportation. Previous positions include acting assistant secretary for economic policy at the U.S. Department of the Treasury; chief economist at the U.S. Department of Labor; and chief of staff of the Council of Economic Advisers under President George W. Bush.

Today I'd like to make the following points:

Poor and middle-class people pay a steep price for President Biden's energy agenda. They suffer a decline in value, safety and security, while the regulations do not mitigate climate change. Americans' jobs in the oil and gas fields are being sacrificed to Chinese nationals (sometimes with forced labor) making wind turbines and solar panels. Americans' jobs in auto plants are being sacrificed to Chinese nationals (sometimes with forced labor) making batteries and electric vehicle components.

Last week Stellantis announced that it would be offering buyouts to 33,500 hourly and white-collar workers in an attempt to cut 3,500 jobs due to its planned transition to electric vehicles.¹ It closed a plant in Illinois in December. General Motors and Ford are also laying off workers as part of their move to make more battery-powered vehicles.

United Auto Workers president Shawn Fain said in a statement on April 26, "Stellantis' push to cut thousands of jobs while raking in billions in profits is disgusting. This is a slap in the face to our members, their families, their communities, and the American people who saved this company 15 years ago. Even now, politicians and taxpayers are bankrolling the electric vehicle transition, and this is the thanks the working class gets. Shame on Stellantis."²

Fossil fuels generate substantial tax revenues for federal, state, and local governments. In contrast to fossil fuels, renewables get substantial subsidies and generate comparatively few tax revenues. Renewables raise the costs of electricity, which disproportionately affects the poor and

¹ Ryan Felton and Nora Eckert, "Jeep Maker Stellantis to Offer Buyouts to Hourly, Salaried Workers," *The Wall Street Journal*, April 26, 2023, <https://www.wsj.com/articles/jeep-maker-stellantis-to-offer-buyouts-to-hourly-salaried-workers-d3c71fd6> (accessed May 1, 2023).

² United Auto Workers, UAW Statement on Job Cuts at Stellantis, <https://uaw.org/uaw-statement-job-cuts-stellantis/#:~:text=%E2%80%9CStellantis%20push%20to%20cut%20thousands,this%20company%2015%20years%20ago> (accessed May 1, 2023).

middle class. President Biden's plan to transition away from fossil fuels is making the United States weaker and China stronger, without noticeable effects on global temperatures, using the Model for the Assessment of Greenhouse Gas Induced Climate Change developed by researchers at the EPA, which is used for such calculations at the Heritage Foundation. In order to comply with recent proposed rules by the Environmental Protection Agency to regulate tailpipe emissions, 60% of vehicle sales would have to be battery powered electric in 2030, and 67% in 2032.³ This would be impractical, costly, and less safe for drivers. The Department of Energy also wants to regulate a variety of other appliances, depriving Americans of the ability to have a simple gas stove⁴—an appliance that goes back almost 200 years. Poor and middle-class people will be paying the price for these rules, both proposed and enacted.

Fossil fuels are also essential for agriculture. Reliable energy availability creates cheap food, jobs, and more productive economic growth. This contributes to lower greenhouse gas emissions in the long run. If the world gives up its energy and agricultural security, countries will be left with the insecurity of higher food and transportation costs, higher electricity costs, and lost jobs, with decreased food access, with the poor paying most of the price. High food and energy costs in emerging economies reduce economic growth, leading to pressures to migrate to countries with job opportunities, particularly in Europe and North America.

Tax Provisions for Fossil Fuels

The best tax policy would be to abolish all energy subsidies and mandates, which distort investment and consumption choices. President Biden wants to raise an additional \$120 billion taxes on fossil fuel producers over the next decade. This would raise prices of electricity, heating, and gasoline, and disproportionately hurt low-income Americans, who spend a high proportion of their income on electricity and motor fuel.

The fossil fuel industry already pays substantial taxes, and gasoline is one of the most highly taxed products after labor. Many tax provisions for fossil fuels apply to other industries. For instance, capital cost recovery provisions, which cost \$14 billion over 10 years, allow fossil fuel companies to deduct certain expenditures in the same way that is common in other industries.⁵ President Biden proposes that these deductions be spread over a period ranging from 5 to 39 years, or disallowed completely. One tax deduction for fossil fuels is for intangible drilling costs, which costs \$10 billion over 10 years,⁶ and has parallels in tax deductions in other industries. For example, if a pharmaceutical company invests in research in drugs that are not brought to market, the company can write off those costs.

³ News Release, "Biden-Harris Administration Proposes Strongest-Ever Pollution Standards for Cars and Trucks to Accelerate Transition to a Clean-Transportation Future," U.S. Environmental Protection Agency, April 12, 2023, <https://www.epa.gov/newsreleases/biden-harris-administration-proposes-strongest-ever-pollution-standards-cars-and-trucks> (accessed April 28, 2023).

⁴ *Federal Register*, Vol. 88, No. 21 (February 1, 2023) pp. 6818–6904.

⁵ For a detailed discussion, see e.g. Alex Muresianu and William McBride, "A Guide to the Fossil Fuel Provisions of the Biden Budget," Tax Foundation *Fiscal Fact* No. 778, September, 2021, <https://taxfoundation.org/biden-fossil-fuel-tax/> (accessed May 1, 2023).

⁶ U.S. Department of the Treasury, "General Explanations of the Administration's Fiscal Year 2022 Revenue Proposals," p. 104, May 2021, <https://home.treasury.gov/system/files/131/General-Explanations-FY2022.pdf>, (accessed May 1, 2023).

All firms benefit from foreign tax credits, and oil companies can treat royalties as fully deductible foreign income tax. Many oil and gas companies are set up as Master Limited Partnerships, as are companies in other industries.⁷

Other tax provisions are specific to fossil fuels. Small independent producers benefit from percentage depletion, which is an accelerated depreciation method used by small independent producers and owners of royalties. Percentage depletion for oil and gas wells cost \$9 billion over 10 years.⁸ From 2019 to 2023, the Joint Committee on Taxation estimates the credit for investments in clean coal facilities cost about \$200 million a year.⁹ During the same period, the credit for carbon sequestration is estimated to cost a total of \$100 million.¹⁰

These financial incentives are far smaller than those for wind and solar. In April the Joint Tax Committee estimated that green tax credits from the Inflation Reduction Act will cost \$570 billion from 2023 to 2033.¹¹ As of 2022, wind and solar power produced less than 6% of our domestic primary energy consumption.¹² The reality is that the federal government is spending billions on renewables, making electricity more expensive, and getting billions in revenues from the oil and gas sector, with vast benefits for consumers. The poor and middle class are paying the higher electricity prices.

The oil and gas industry generates direct revenues for the federal government in the form of corporate income taxes, excise taxes on gasoline, and fees for oil and gas leasing on federal lands. The oil and gas extraction industry paid 19% of income in federal taxes in 2018, compared to 11% for industries as a whole.¹³ In fiscal 2019, the last full year before the pandemic, the federal government collected and disbursed to states over \$4 billion from oil and gas leasing on onshore federal lands.¹⁴ Federal gas taxes bring in \$42 billion a year and are expected to do so over the next decade, according to the Congressional Budget Office's baseline projection.¹⁵ The availability of affordable oil and gas also generates indirect revenues by increasing GDP and encouraging manufacturing from other countries to locate in the United States.

⁷ Liz Manning, "Master Limited Partnership (MLP)", Investopedia, updated May 24, 2022, <https://www.investopedia.com/terms/m/mlp.asp> (accessed April 28, 2023).

⁸ U.S. Department of the Treasury, "General Explanations of the Administration's Fiscal Year."

⁹ The Joint Committee on Taxation, U.S. Congress, *Estimates on Federal Tax Expenditures for Fiscal Years 2019-2023*, December 18, 2019, p.21, <https://www.jct.gov/publications/2019/jcx-55-19/> (accessed April 28, 2023).

¹⁰ *Ibid.*, p. 21.

¹¹ Congressional Budget Office, Letter from Honorable Phillip Swagel to Honorable Jodey Arrington, April 25, 2023, https://www.cbo.gov/system/files/2023-04/59102-Arrington-Letter_LSG%20Act_4-25-2023.pdf (accessed April 29, 2023).

¹² U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3, April 2023, <https://www.eia.gov/totalenergy/data/monthly/pdf/mcr.pdf> (accessed April 29, 2023).

¹³ Internal Revenue Service, Statistics of Income, "Table 5.3 Returns of Active Corporations, other than Forms 1120S, 1120-REIT, and 1120-RIC," <https://www.irs.gov/statistics/soi-tax-stats-corporation-complete-report> (accessed May 1, 2023).

¹⁴ Brandon S. Tracy, "Revenues and Disbursements from Oil and Natural Gas Production on Federal Lands," Congressional Research Service *Report for Congress*, September 22, 2020, p. 13 <https://crsreports.congress.gov/product/pdf/R/R46537> (accessed April 30, 2023).

¹⁵ Congressional Budget Office, "The Budget and Economic Outlook: 2023 to 2033," February 2023, <https://www.cbo.gov/system/files/2023-02/58848-Outlook.pdf> (accessed April 30, 2023).

States collect oil and gas taxes from gasoline and diesel excise taxes; state taxes levied on the value or volume of oil and gas produced; property taxes on the value of oil and gas property; oil and gas lease revenues from state lands; and oil and gas lease revenues from federal lands. For example, in the last fiscal year ending August 31, 2022, oil and natural gas brought in \$10.8 billion to the State of Texas.¹⁶ In Alaska, the Energy Policy Research Foundation has estimated that the recently-approved Willow Project will have a net present value of \$44.6 billion in 2026, with \$2.8 billion paid in federal royalties and taxes, and \$820 million paid to the State of Alaska in royalties and taxes.¹⁷

EPA's New EV Regulations Weaken America

New proposed regulations¹⁸ on automobile emissions from the Environmental Protection Agency would require new car sales to be 60% battery powered electric by 2030 and 67% by 2032, compared to fewer than 6% in 2022. EPA is also planning new rules for power plants,¹⁹ driving up the costs of the electricity needed to charge these vehicles. These rules would raise driving costs for Americans, and poor and middle-class Americans disproportionately would pay the price.

New electric vehicles cost more than gasoline-powered vehicles. The electric version of the base version of the Ford 150 pickup truck, the best-selling vehicle in America, costs an additional \$26,000.²⁰ Tesla's base prices start at about \$40,000 for a Model 3 and go up to almost \$100,000 for a Model X.²¹ These are staggering costs to impose on American families. Cars are part of the American Dream for many Americans, a dream that for too many American families is put out of reach by these new regulations.

Charging will also cost more. At the same time as EPA issuing new rules for automobile emissions, it is also planning new rules for emissions from power plants, *The New York Times*

¹⁶ News Release, "Texas Comptroller Glenn Hegar Announces Revenue for Fiscal 2022, August State Sales Tax Collections," Texas Comptroller of Public Accounts, September 1, 2022, <https://comptroller.texas.gov/about/media-center/news/20220901-texas-comptroller-glenn-hegar-announces-revenue-for-fiscal-2022-august-state-sales-tax-collections-1662060818986> (accessed April 30, 2023).

¹⁷ Energy Policy Research Foundation, "After Extensive Deliberation The National Petroleum Reserve-Alaska (NPR-A) Willow Project Is Set To Yield Revenue For Both The State And The Federal Government," April 5, 2023, <https://eprinc.org/wp-content/uploads/2023/04/EPRINC-ChartOfTheWeek2023-14-NPRA-WillowProject-NPVAssessment-Version3.pdf> (accessed April 30, 2023).

¹⁸ U.S. Environmental Protection Agency, "Notice of Proposed Rulemaking: Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles," <https://www.epa.gov/system/files/documents/2023-04/ldmv-multi-pollutant-emissions-my-2027-nprm-2023-04.pdf> (accessed April 28, 2023).

¹⁹ Valerie Volcovici, "Biden EPA to Issue Power Plant Rules That Lean on Carbon Capture," Reuters, April 24, 2023, <https://www.reuters.com/business/sustainable-business/biden-epa-issue-power-plant-rules-that-lean-carbon-capture-2023-04-23/> (accessed April 28, 2023).

²⁰ Ford Motor Company, Models & Specs, 2023 F-150 XL, <https://www.ford.com/trucks/f150/models/?gnav=vhpnav-specs> (accessed April 28, 2023); and Ford motor Company, Models & Specs, 2023 F-150 Lightning PRO, <https://www.ford.com/trucks/f150/f150-lightning/models/?gnav=vhpnav-specs> (accessed April 28, 2023).

²¹ Tesla, Model 3, Purchase Price, <https://www.tesla.com/model3/design#overview> (accessed April 28, 2023); and Tesla, Model X, Purchase Price, <https://www.tesla.com/modelx/design#overview> (accessed April 28, 2023).

has reported.²² According to the reports, EPA will regulate carbon dioxide and other so-called greenhouse gas emissions from both new and existing natural gas and coal-fired power plants, and require carbon capture systems or a switch to hydrogen fuels. These systems for capturing carbon are costly and will be passed on to consumers in the form of higher electricity rates. Drivers will find it more expensive to use electricity for all purposes, including charging their electric vehicles, harming poor and middle-class drivers the most.

Some states, such as California and Texas, have experienced many brownouts and blackouts in recent years as the existing electric grid cannot meet existing demand. Few new net sources of electricity generation are coming online. Electricity is not a fully reliable source of energy in these states. Moreover, it is becoming increasingly expensive. Pacific Gas and Electric has advised its customers that the average electricity bill will be \$187 a month as of March 1, 2023, and increase of 5% from January 1, 2023. Over the past two years rates have risen by almost a third.²³ Upper-income residents can afford backup generators to deal with blackouts, but poor and middle-income residents cannot. Food spoils in their refrigerators and their children cannot do homework without electricity for lights and computers.

Three-quarters of vehicles sold are previously owned cars.²⁴ In 2019, the last year for which complete data on used car sales are available, Americans bought 41 million used cars and 13 million new cars.²⁵ But people do not want to buy used electric vehicles, because it is difficult to evaluate how long the battery will last. Replacing an EV battery can cost anywhere from \$5,000 to \$20,000.²⁶ The poor and middle class will suffer most from higher prices for used vehicles, because they cannot afford the new electric vehicles.

Mandating electric vehicles would reduce Americans' standard of living. Back in the early 1900s, when Henry Ford started producing cars, only rich Americans could afford them. Throughout the 20th century cars became less expensive, and many households can afford not one but two. Cars are already becoming more expensive, and the proposed rule accelerates that trend, taking America back a century, where new cars will be only for the rich.

Recharging an electric vehicle from empty can take over an hour, compared to 5 minutes to fill up with gas.²⁷ If there is a line to use the charging station the wait can double. Most people do not want to let their EV battery go below 20%, and the charging rate goes down when it is

²² Coral Davenport and Lisa Friedman, "E.P.A. to Propose First Controls on Greenhouse Gases from Power Plants," *New York Times*, updated April 27, 2023, <https://www.nytimes.com/2023/04/22/climate/epa-power-plants-pollution.html> (accessed April 28, 2023).

²³ California Public Utilities Commission, Rate Change Advisories, <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/rate-change-advisories> (accessed April 30, 2023).

²⁴ Mathilde Carlier, Statista, New and Used Light Vehicle Sales in the United States, 2010 to 2021, <https://www.statista.com/statistics/183713/value-of-us-passenger-car-sales-and-leases-since-1990/> (accessed April 28, 2023).

²⁵ U.S. Department of Transportation, Bureau of Transportation Statistics, New and Used Passenger Car and Light Truck Sales and Leases Data Set, 1990 to 2021, <https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles> (accessed April 28, 2023).

²⁶ Recurrent, "Updated: Electric Car Battery Replacement Costs," March 26, 2023, <https://www.recurrentauto.com/research/costs-ev-battery-replacement> (accessed April 28, 2023).

²⁷ Lazar, "How Long Does It Take to Refuel a Gasoline Car? GasAnswer, <https://gasanswer.com/how-long-take-refuel-gasoline-car/> (accessed April 28, 2023).

charged over 80%.²⁸ Throughout America the poor rarely have access to indoor garages for overnight charging, and in most large cities, such as New York City, the middle-class also have no access to indoor charging. Using charging stations on the street, if available, risks theft of expensive charging cables.

Battery-powered vehicles lack sufficient range to satisfy most customers. Although 60 to 70 miles of range is enough for most trips, people buy cars for all circumstances, including vacations and cold weather. Moreover, batteries lose up to 40% of their range in cold climates.²⁹ A study by Autocar³⁰ shows that electric vehicles lose, on average, a third of their range in the winter, which reduces the typical 240-mile range to 160 miles. If a heat pump is added to the car, the loss is less, but still the 240-mile range would shrink to 180.

Car results varied. The Fiat 500 42kWh Icon lost 40% of its range in the winter.³¹ The Ford Mustang Mach-E Extended Range RWD lost 35%, and the Porsche Taycan 4S Performance Battery Plus, with heat pump, lost 22% (the Taycan costs between \$83,000 and \$166,000).³²

The loss of range in cold weather is one reason why, at the end of 2021, the latest full year available, North Dakota has 380 electric vehicle (EV) registrations, the fewest in the United States, according to the Energy Department.³³ North Dakota will receive \$26 million for charging stations, according to the Department of Transportation,³⁴ or \$68,000 per registered EV. Wyoming, with \$27 million and 510 EVs, gets \$53,000 per EV.³⁵ South Dakota, with \$29 million, has 680 vehicles, and will collect \$43,000 per vehicle.³⁶ Alaska had 1,290 registered electric vehicles (EVs). Alaska will get \$52 million³⁷ of the \$7.5 billion that the new Infrastructure Investment and Jobs Act allocates to states for electric charging stations.³⁸ That works out to more than \$40,000 per electric vehicle. These funds could be saved or put to better use.

²⁸ Sebastian Blanco, "How to Maximize EV Range," J.D. Power, July 20, 2022,

<https://www.jdpower.com/cars/shopping-guides/how-to-maximize-ev-range> (accessed April 28, 2023).

²⁹ Ellen Edmonds, "Icy Temperatures Cut Electric Vehicle Range Nearly in Half," AAA News Room, February 7, 2019, <https://newsroom.aaa.com/2019/02/cold-weather-reduces-electric-vehicle-range/> (accessed April 28, 2023).

³⁰ Move Electric, "Electric Vehicle Range Test Reveals Up to 20% Drop in Winter," Autocar, March 17, 2022, <https://www.autocar.co.uk/car-news/move-electric/electric-vehicle-range-test-reveals-20-drop-winter> (accessed April 28, 2023).

³¹ Ibid.

³² Ibid.

³³ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Electric Vehicle Registrations by State Data Set, updated June 2022, <https://afdc.energy.gov/data/10962> (accessed April 28, 2023).

³⁴ U.S. Department of Transportation, Federal Highway Administration, 5-Year National Electric Vehicle Infrastructure Funding by State Data Set, FY 2022 to FY 2026, updated September 13, 2022, https://www.fhwa.dot.gov/bipartisan-infrastructure-law/evs_5year_nevi_funding_by_state.cfm (accessed April 28, 2023).

³⁵ Ibid.

³⁶ Ibid.

³⁷ Ibid.

³⁸ News Release, "President Biden, U.S. Department of Transportation Releases Toolkit to Help Rural Communities Build Out Electric Vehicle Charging Infrastructure," U.S. Department of Transportation, February 2, 2022, <https://www.transportation.gov/briefing-room/president-biden-us-department-transportation-releases-toolkit-help-rural-communities> (accessed April 28, 2023).

In comparison, there were 563,070 registered EVs in California and 95,640 in Florida, according to the Energy Department.³⁹ California is getting a much larger allocation for its charging stations, \$384 million over 5 years.⁴⁰ Drivers in the Golden State use EVs, so the stations will at least get some use. On a per vehicle basis, this works out to \$682 per registered EV. But with California drivers piloting expensive Teslas and Hummers down sunny freeways, reasonable people might ask why electric charging stations need to be provided by the taxpayer.

Minerals such as lithium and cobalt are essential for batteries. Mining for these minerals is energy-intensive, and the Chinese Communist Party (CCP) has facilitated access to domestic and foreign minerals for battery production. Lithium is mined in western China's Qinghai Province, aided by government funding, and China purchases cobalt for electric batteries from Kisanfu, in the Democratic Republic of Congo.⁴¹ The United States makes opening new mines virtually impossible, even though the jobs generated would help all Americans, particularly the poor and middle class. Thus, the rule will result in a massive increase in mining in countries that have no respect for the environment or human welfare. The sorts of mining that will be conducted as a result of the rule will be bad for the environment and are frequently performed by child workers.

Electric vehicles are not emissions free. In addition to batteries made with fossil fuels, increased electricity demand places additional stress on the electrical grid, as California has found out from rolling blackouts. In its proposal, EPA discusses the benefits of reducing pollutants from cars,⁴² but higher emissions will come from the electricity generated to recharge the cars. This electricity is made with natural gas and coal, because wind and solar powers a small share of America's power. EPA admits that "We expect that in some areas, increased electricity generation would increase ambient SO₂, PM 2.5, ozone, or some air toxics."⁴³

President Biden's Energy Plans Will Make Cars Less Safe

Almost 43,000 people died on the roads in 2022,⁴⁴ the equivalent of 215 plane crashes a year killing 200 people each time. EPA's tailpipe emissions proposal would, if implemented, make Americans even less safe on the road. The prior 2022 fuel economy proposal⁴⁵ from the National Highway Transportation and Safety Administration (NHTSA) raises the 2026 Corporate Average Fuel Economy standard to 49 miles per gallon (MPG) from the current standard of 40 MPG. The rule sets a new minimum standard of 59.4 MPG for passenger cars and 42.4 MPG for light trucks made in the United States by model year 2026, with fines for non-compliant carmakers. NHTSA concludes that the higher price of cars would increase fatalities because fewer people would be

³⁹ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Electric Vehicle Registrations.

⁴⁰ U.S. Department of Transportation, Federal Highway Administration, 5-Year National Electric Vehicle.

⁴¹ Dionne Searcey, Michael Forsythe, and Eric Lipton, "A Power Struggle Over Cobalt Rattles the Clean Energy Revolution," *New York Times*, December 7, 2021, <https://www.nytimes.com/2021/11/20/world/china-congo-cobalt.html> (accessed April 28, 2023).

⁴² U.S. Environmental Protection Agency, "Notice of Proposed Rulemaking."

⁴³ *Ibid.*, p. 48.

⁴⁴ National Highway Transportation Safety Administration, "NHTSA Estimates for 2022 Show Roadway Fatalities Remain Flat After Two Years of Dramatic Increases," April 20, 2023, <https://www.nhtsa.gov/press-releases/traffic-crash-death-estimates-2022> (accessed April 30, 2023).

⁴⁵ *Federal Register*, Vol. 87, No. 84, (May 2, 2022), pp. 25710-26092, <https://www.govinfo.gov/content/pkg/FR-2022-05-02/pdf/2022-07200.pdf> (accessed May 1, 2023).

able to afford the safer, newer, cars, “The slowing of fleet turnover due to higher vehicle prices has the largest impact of the three factors on fatalities.”⁴⁶

NHTSA estimates that the decline in new vehicle sales would result in up to 812 additional deaths on the road each year, 16,206 more injuries, and almost 50,000 more crashes involving property damage.⁴⁷ This is because fewer people would be able to afford new and later-model used cars, which are safer than old cars. EPA’s proposed regulations would make the situation worse.

This increase in prices caused by successive reductions in emissions contradicts NHTSA’s core values,⁴⁸ namely leading “the Nation by setting the motor vehicle and highway safety agenda,” and serving “as the catalyst for addressing critical safety issues that affect the motor vehicle and highway safety communities.” Deaths and injuries from the new rules would be concentrated among low-income Americans, disproportionately minorities, who would pay the price of the new rule: due to the price increases, they would buy fewer new cars and fewer later-model used cars.

The push towards expensive electric vehicles directly contradicts the Department of Transportation’s focus on “Health and Equity.” According to the Department,⁴⁹ “households in low-income areas typically own fewer vehicles, have longer commutes, and have higher transportation costs.” These are the people who will pay the price for new EPA regulations. Their cars will be older, less safe, and break down more frequently, resulting in higher repair and maintenance costs.

In addition, if people choose not to buy the mandated electric vehicles, carmakers will have to reduce their prices and raise prices of popular pickup trucks and SUVs to stay profitable.⁵⁰ Lower-income and Americans in rural areas will be paying more for their preferred vehicles, subsidizing better-off residents in cities and California, who are the main purchasers of electric vehicles.

Automakers will be harmed both by higher prices of the new cars, which will reduce vehicle sales, and by the subsidies for electric vehicles. The increased deaths, injuries, property damage, and offshored carmakers’ jobs should concern President Biden and others who value road safety and employment.

Fossil Fuels Are Needed for Food and Border Security

Not only our energy security, but also our agricultural production and food security, depend on fossil fuels. Raising the price of fossil fuels raises the cost of food, and the poor and middle class

⁴⁶ Ibid., p. 25896.

⁴⁷ Ibid., pp. 25894-5.

⁴⁸ U.S. Department of Transportation, National Highway Traffic Safety Administration, “NHTSA’s Core Values,” <https://www.nhtsa.gov/about-nhtsa/nhtsas-core-values> (accessed May 1, 2023).

⁴⁹ U.S. Department of Transportation, “Health and Equity,” updated December 17, 2013, <https://www.transportation.gov/mission/health/health-equity> (accessed May 1, 2023).

⁵⁰ For a detailed analysis, see Steve Bradbury, “Observation: Cliff Notes,” Substack: Adespotoi, September 16, 2022, <https://adespotoi.substack.com/p/observation-cliff-notes> (accessed May 1, 2023).

pay the price. Ammonia is a key component of fertilizer manufacturing, and producing it requires natural gas.

Fossil fuels are essential for food production, and climate restrictions will only send prices higher. Over the past year U.S. food prices have risen 8.5%, according to the Bureau of Labor Statistics, disproportionately harming the poor and the middle class. Cereals were up 13%, bakery products up 14%, poultry was up 7%, and dairy was up 11%.⁵¹

When Russia cut off natural gas to Europe, helping to send the globe into near-recession conditions, the world learned the importance of energy security. Agricultural and food security are equally important.

The Rhodium Group is forecasting that agricultural emissions will make up 30% of U.S. total greenhouse gas emissions by 2050.⁵² Nevertheless, fossil fuels are vital to fertilizers and pesticides, which improve crop production and reduce food prices. In 2021, Sri Lanka President Gotabaya Rajapaksa banned synthetic fertilizer and pesticide imports practically overnight, leaving Sri Lanka's farmers with only organic substitutes, because he claimed that chemical fertilizers and pesticides were leading to "adverse health and environmental impacts."

Six months later, rice production had dropped by 20% and tea production had declined by 18%. Rice is a staple in the country and tea is a vital export. In 2022, with inflation at 55% and the economy in tatters, protestors took over Rajapaksa's home, his government fell, and he had to flee the country.

Protests are also occurring in the Netherlands and Belgium as policymakers attempt to curtail fossil fuels in agriculture. Farmers are rioting because they are losing their livelihoods in the name of fighting climate change as European governments seek to reduce emissions of nitrogen oxide and ammonia, necessary inputs of modern agriculture.

European farmers are being told that because of the aim for "net-zero emissions" of greenhouse gases and other so-called pollutants in 2050, their industry is being phased out. The Dutch government wants to cut emissions of pollutants, predominantly nitrogen oxide and ammonia, by 50% nationwide by 2030. Ministers warn that farmers will have to adapt or face the prospect of shuttering their businesses.

Will American farmers and consumers soon face the same fate? Congress will pass a farm bill this year, and with the Inflation Reduction Act funneling \$20 billion of climate funds into agriculture, American farmers could face similar pressures.

This disproportionately hurts the poor, who spend a higher share of their income on food. Food access for poor people is at stake. Despite billions of dollars spent by international aid

⁵¹ Bureau of Labor Statistics, Consumer Price Index, March 2023, released April 12, 2023, <https://www.bls.gov/news.release/pdf/cpi.pdf> (accessed May 1, 2023).

⁵² Rhodium Group, "Taking Stock 22: US Greenhouse Gas Emissions Outlook in an Uncertain World," July 14, 2022, https://rhg.com/wp-content/uploads/2022/07/Taking-Stock-2022_US-Emissions-Outlook.pdf (accessed May 1, 2023).

organizations, many people lack food, modern energy, electricity, and running water. One-third of the Earth's population needs energy from fossil fuels, such as oil, natural gas, coal, or nuclear power, to bring people up to Western standards.

Groups such as the Swiss-based Center for International Environmental Law are pressuring international development organizations, private corporations, and pension funds not to invest in conventional fuels, even for food. The center's October report⁵³ states in its executive summary, "Agriculture accounts for roughly a third of global greenhouse gas (GHG) emissions, and fossil fertilizers—synthetic fertilizers derived from fossil fuels—are an unrecognized contributor to this figure."⁵⁴ But the poverty that results from higher food and electricity costs leads to migration and pressures on borders, as people flee Africa for Europe and flee Latin America for North America in search of jobs and fossil-fueled prosperity.

Countries will never reach Western income levels using only wind and solar. The misguided policies of Western countries to discourage energy use condemn billions of people around the world to impoverished lives and hunger. This poverty is merely collateral damage for the consciences of Western elites.

America Pays the Price: President Biden's Energy Plans Are Strengthening China

America is paying the price of President Biden's energy agenda, and China is the winner. President Biden's plans will strengthen China's economy, because China makes nearly 80% of the world's electric batteries,⁵⁵ 66% of global solar panels,⁵⁶ and 50% of wind turbines.⁵⁷ This is especially troubling because the Chinese Communist Party (CCP) is a totalitarian regime which has a poor record both on the environment and on human rights. Beijing is engaged in genocide against the minority Uyghur people of Xinjiang and has imposed draconian restrictions on political freedoms in Hong Kong.⁵⁸ The CCP has reduced or eliminated religious liberties for Christians and Buddhist worshippers of the Dalai Lama throughout Tibet.⁵⁹ Empowering the Chinese government is fundamentally at odds with "good corporate governance."

Rather than using its own oil and natural gas resources, America will depend on energy from China. Countless other renewable energy components and technologies also depend to a large

⁵³ Center for International Environmental Law, "Fossils, Fertilizers, and False Solutions: How Laundering Fossil Fuels in Agrochemicals Puts the Climate and the Planet at Risk," October 2022, <https://www.ciel.org/wp-content/uploads/2022/10/Fossils-Fertilizers-and-False-Solutions.pdf> (accessed May 1, 2023).

⁵⁴ Ibid., pp. 1-2.

⁵⁵ Veronika Henze, "China's Battery Supply Chain Tops BNEF Ranking for Third Consecutive Time, with Canada a Close Second," BloombergNEF, November 12, 2022, <https://about.bnef.com/blog/chinas-battery-supply-chain-tops-bnef-ranking-for-third-consecutive-time-with-canada-a-close-second/> (accessed April 28, 2023).

⁵⁶ "66% of total solar panel imports are from China: Piyush Goyal", The Economic Times, updated December 3, 2015, <https://economictimes.indiatimes.com/industry/energy/power/66-of-total-solar-panel-imports-are-from-china-piyush-goyal/articleshow/50028009.cms?from=mdr> (accessed April 28, 2023).

⁵⁷ Jillian Ambrose, "China Leads World's Biggest Increase in Wind Power Capacity", The Guardian, March 10, 2021, <https://www.theguardian.com/business/2021/mar/10/china-leads-world-increase-wind-power-capacity-windfarms#:~:text=The%20report%2C%20by%20Bloomberg%20New.wind%20power%20growth%20in%202019> (accessed April 28, 2023).

⁵⁸ James J. Carafano et al., "Winning the New Cold War," p. 24.

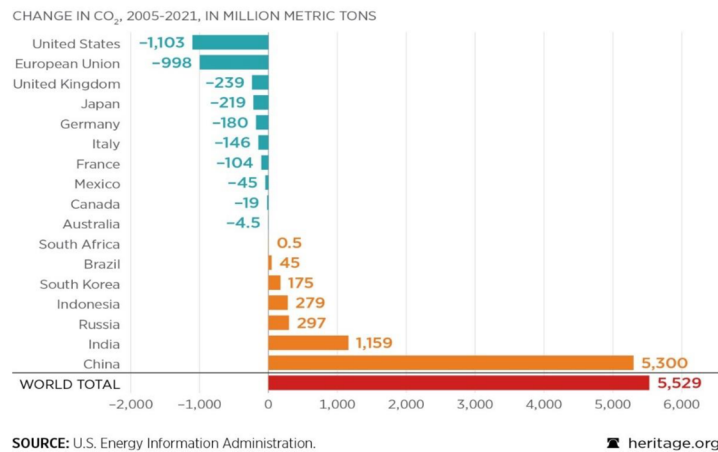
⁵⁹ Ibid., p. 3.

extent on Chinese supply chains. For instance, many of the components of batteries will either be sourced, processed, or manufactured in China for the foreseeable future. Middle-class Americans are losing jobs at Stellantis, Ford, and GM due to the forced switch to electric vehicles. Recent efforts to require battery manufacturing in the U.S. mask the source of the components. In contrast, none of the gasoline or diesel fuels for transportation are from China.

In order to produce supplies of renewables, China is increasing its construction of coal-fired power plants. America has 225 coal-fired power plants, and China has 1,118 (half of all the coal-fired plants in the world).⁶⁰ That is one reason why China has increased carbon emissions by over 5,000 million metric tons over the past 16 years.⁶¹ In contrast, America's carbon emissions have declined by over 1,000 million metric tons over the same period due to the use of clean natural gas.⁶² (See Figure 1.)

Figure 1

CO₂ Emissions Trends in Key Countries, 2005-2021



A new report by the Heritage Foundation, *Winning the Cold War: A Plan for Countering China*,⁶³ shows how America's environmental policies benefit China and harm America.

Heritage issued the report on the same day that the House of Representatives introduced H.R. 1,

⁶⁰ Jessica Aizarani, Statista, "Global operational coal-fired power stations by country 2022," January 30, 2023, <https://www.statista.com/statistics/859266/number-of-coal-power-plants-by-country/> (accessed April 28, 2023).

⁶¹ The Heritage Foundation, CO₂ Emissions Trends in Key Countries Data Set, 2005-2021.

⁶² Ibid.

⁶³ James J. Carafano et al., "Winning the New Cold War: A Plan for Countering China," Heritage Foundation Special Report No. 270, March 28, 2023, https://www.heritage.org/sites/default/files/2023-03/SR270_0.pdf (accessed April 28, 2023).

The Lower Energy Costs Act,⁶⁴ sponsored by Majority Leader Steve Scalise (R-LA), Energy and Commerce Committee Chair Cathy McMorris Rodgers (R-WA), Bruce Westerman (R-AR), and Transportation and Infrastructure Committee Chair Sam Graves (R-MO). The bill emphasizes domestic energy production, lower energy costs, and reduction in emissions.

The Heritage report recommends the following.

First, Congress and the Executive branch should identify and discourage environmental policies that benefit China or make America dependent on Chinese energy sources and supply chains.

Second, Congress should pass laws that prevent state and federal agencies from imposing regulatory requirements that make critical infrastructure or supply chains more dependent on China.

Third, the Federal government should enhance scrutiny of ESG ratings and prevent regulators from taking actions that promote ESG scores.

Fourth, the government should educate foreign governments, the private sector, and civil society about the CCP's manipulation of ESG issues.

Fifth, the government should prevent the imposition of net zero policies at the state level. Much could be done by individual states. State legislators should oppose environmental policies that prevent asset managers from maximizing returns for beneficiaries. State pension funds should be invested with a goal of the highest returns to fiduciaries.

Rather than kowtowing to China, companies should reject environmental policies that raise the costs of doing business and favor the CCP. The rush to a green energy future, driven more by politics and virtue-signaling than economics and emissions reductions, will only enrich China at America's expense and place vital energy supply chains at mercy of Beijing.

China has not committed to reducing emissions until 2027. Research by Dr. Kevin Dayaratna, chief statistician and senior research fellow at The Heritage Foundation, has shown that even completely eliminating all fossil fuels from the United States would result in less than 0.2 degrees Celsius in temperature mitigation by 2100.⁶⁵ Americans, particularly poor and middle class, would be bearing major costs in higher electricity prices, higher food prices, and a forced switch to costly electric vehicles without benefits for the environment. They would pay the price for President Biden's energy agenda.

⁶⁴ Lower Energy Costs Act, H.R. 1, 118th Congress, Session 1, (2023)
<https://www.congress.gov/118/bills/hr/1/BILLS-118hr1ih.pdf> (accessed April 28, 2023).

⁶⁵ Kevin D. Dayaratna, PhD, Katie Tubb, and David Kreutzer, "The Unsustainable Costs of President Biden's Climate Agenda," Heritage Foundation *Background* No. 3713, June 16, 2022,
https://www.heritage.org/sites/default/files/2022-06/BG3713_0.pdf, (accessed May 1, 2023).

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Ted Gayer, President, Niskanen Center
 Response to Questions for the Record from Senator Chuck Grassley
 Who Pays the Price: The Real Cost of Fossil Fuels
 Senate Budget Committee
 May 3, 2023

Question #1:

I'm sure you are aware, as President of Niskanen Center, that your organization receives funding from dark-money sources. One of these sources is the Hopewell Fund, an arm of the multi-billion dollar left-wing dark money group, Arabella Advisors. Another source of your funding is the Litterman Family Foundation. It is run by the same Dr. Robert Litterman who testified for the Democrats in favor of a carbon tax at our first climate change hearing.

- Does the Niskanen Center receive funding from sources that do not disclose their donors?
- Does the Niskanen Center receive funding from donors linked to the Arabella Advisors?
- Do you believe that this funding plays a significant role in furthering the Democrat's political objectives?
- The Chairman often asserts his belief that the testimony and views of witnesses are affected by their current or former employer's donors. Do you agree with this belief? If so, are your views or the views of the Niskanen Center affected by your donors?

Response:

The Niskanen Center has a policy of disclosing its donors, but on rare occasions in the past it has received funding from anonymous donors. In these instances, the funding is usually in small increments and negligible to the resource needs of the organization. The Niskanen Center has never received funding from Arabella Advisors. It is possible that people's policy views are influenced by donors, but my personal approach is to argue the merits of a point rather than the motivations for making the point.

Question #2:

Dr. Gayer, even many supporters of a carbon tax acknowledge that it would generally be regressive in nature. A 2009 working paper from the National Bureau of Economic Research titled "Who Pays a Price on Carbon?" notes that "Our results suggest that the burden as a percent of annual income is much higher among lower income groups than higher income groups." More recently, a World Bank blog post notes that "a carbon tax on fossil fuels is often regressive in its impact-hurting poorer people relatively more than richer ones."

The Niskanen Center acknowledges the regressive nature of a carbon tax, when noting "A well-designed carbon tax that makes good use of the revenue it generates would offset increased energy costs to consumers and make the tax more progressive."

- During the hearing, it was suggested that a carbon tax would be a tool for deficit reduction. Wouldn't using revenues raised by a carbon tax for deficit reduction instead of some sort of "revenue recycling" preserve the regressive nature of the tax?

Response:

There is a wide array of policy options for using revenue generated by a carbon tax, including for tax cuts, infrastructure financing, deficit reduction, or dividend programs. Congress has an opportunity to combine a set of priorities in a way that meets multiple goals. Targeted relief to low-income households may require [as little as 10%](#) of revenue generated by a carbon tax to offset the regressive effects. This leaves potentially 90% of the revenue available for Congress' preferred suite of complementary policies.

Question #3:

In defending and promoting a carbon tax, the Niskanen Center positively compares a carbon tax to climate regulations. A paper titled "Carbon Pricing and Regulations Compared – An Economic Explainer" notes that "Carbon pricing has significant advantages compared to command-and-control regulation."

At this point the Biden administration is going full-speed ahead with command-and-control climate regulations. Aside from fuel efficiency standards that will be crippling for middle-class Americans, the Biden administration is attempting to impose climate related regulations across the government from using the SEC to impose climate reporting on public companies to the EPA and U.S. Army Corps of Engineers regulating water runoff on farms.

- Is your support for a carbon tax contingent upon it being paired with the elimination or a significant reduction of climate regulations? Please explain why or why not.

Response:

The Niskanen Center has helped Members of Congress design carbon taxes that include regulatory moratoriums and rollbacks contingent on meeting emissions reduction targets. Providing industries with clear market incentives to decarbonize is the most efficient tool available to reach our decarbonization goals. A broad-based carbon tax would create opportunities for removing redundant greenhouse gas regulations and provide businesses the flexibility to reduce their emissions in the most cost-effective way.

Question #4:

In your written testimony, you note that "since fossil fuel subsidies are relatively small, their elimination would have a minimal impact on both fossil fuel production and prices." In his opening statement, Chairman Whitehouse notes, "In the United States, by some estimates taxpayers pay about \$20 billion dollars every year to the fossil fuel industry." Chairman

Whitehouse goes on to say that “It’s dirty work for an industry that controls one of the main political parties in this country.”

- Do you stand by your assessment that fossil fuel subsidies are “relatively small” and agree that in the case of some tax provisions such as percentage depletion, large integrated oil companies do not even benefit from them?
- Do you agree with Chairman Whitehouse that fossil fuels control “one of the main political parties” to the end of protecting subsidies that “are relatively small?”

Response:

Yes, fossil fuel subsidies are relatively small compared to subsidies provided to other industries and the total federal budget. Some tax expenditures such as percentage depletion are only applicable to independent oil and gas producers. Some provisions such as expensing of intangible drilling assets provide more generous treatment to independent oil and gas producers compared to integrated producers. Nonetheless, as I stated in my testimony, regardless of their magnitude, fossil fuel subsidies move us away from energy prices that accurately represent the external costs associated with their use.

RESPONSE TO QUESTIONS FOR THE RECORD FROM SENATOR CHUCK GRASSLEY
 COMMITTEE ON THE BUDGET
 of the UNITED STATES SENATE

Hearing on “*Who Pays the Price: The Real Cost of Fossil Fuels*”
 May 3, 2023

Nicole C. Deziel, PhD, MHS
 Associate Professor
 Yale School of Public Health, Department of Environmental Health Sciences
 Yale School of the Environment
 Yale School of Engineering & Applied Science, Department of Chemical and Environmental Engineering

Question #1:

According to the Congressional Budget Office, total emissions of CO₂ in the electric power sector have declined by 35 percent since 2005. Emissions from coal-fired generation declined by almost 55 percent. About two-thirds of this decline in CO₂ emissions has occurred because of the switch from coal to natural gas. Another one-third has come from renewable sources, like wind, which do not release CO₂.

• Does your analysis take into account natural gas’ role in reducing CO₂ emissions?

During combustion, natural gas emits lower amounts of CO₂ per unit energy compared to coal (1). However, when considering the entire lifecycle of natural gas, some studies have found that the greenhouse gas emissions are similar to coal or oil (2, 3). Although the analysis of total fugitive methane emissions is an area of ongoing research, methane emissions do occur throughout the natural gas development lifecycle, with some of the highest emissions reported for the production, gathering, and storage processes (4-6). Some emissions, such as flaring and venting, are intentional, whereas others occur due to equipment failure or malfunction. Although total emissions may vary, natural gas clearly contributes climate-driving methane emissions, as documented in the most recent International Panel on Climate Change report (7). In summary, it is important to consider the greenhouse gas emissions across the entire lifecycle of any energy source.

• Given that you believe climate change caused by fossil fuel consumption is causing negative health externalities, is it important to recognize the many economic and environmental benefits that fossil fuels offer to society?

There may be many important benefits of shale gas such as increases in employment, increases in wages, or increases in income for residents leasing their land or mineral rights (8, 9). However, there is evidence that these benefits are not distributed equally (10-13). Natural gas also has the benefit of providing reliable generation (i.e., around-the-clock electricity for local communities). However, its complex infrastructure and supply chain, consisting of pipelines, storage facilities, and compressor stations, are vulnerable to interruptions of service from weather events or natural disasters (14). Therefore, policymakers, communities, and other stakeholders should consider the multiple dimensions of both impacts and benefits across the lifecycle of production and usage when making decisions regarding reliance on natural gas and potential substitution energy sources such that energy sources are selected with health, equity, and climate in mind (14).

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Questions for the Record from Senator Chuck Grassley
To: Ms. Diana Furchtgott-Roth
Who Pays the Price: The Real Cost of Fossil Fuels
May 3, 2023
Senate Budget Committee

Question #1:

As I noted in my opening statement, we don't agree on everything, but I welcomed your insightful opinion. Your economic acumen is one of the reasons that I was glad to invite you to testify. Knowing that you are an economist, you were deliberately asked a question regarding anthropogenic climate change, to which you responded that your expertise is in the field of economics. You then cited the work of Dr. Steve Koonin, Undersecretary for Science in the Obama Administration's Department of Energy, which discusses the realm of debate regarding the science behind man's impact on the climate. The Chairman then noted that your position is one that "the Republican Party intends to standby."

- Do you speak for the Republican Party, as a whole? Moreover, do you think that diversity of thought is valuable to inform members of Congress and the public at committee hearings?

Response:

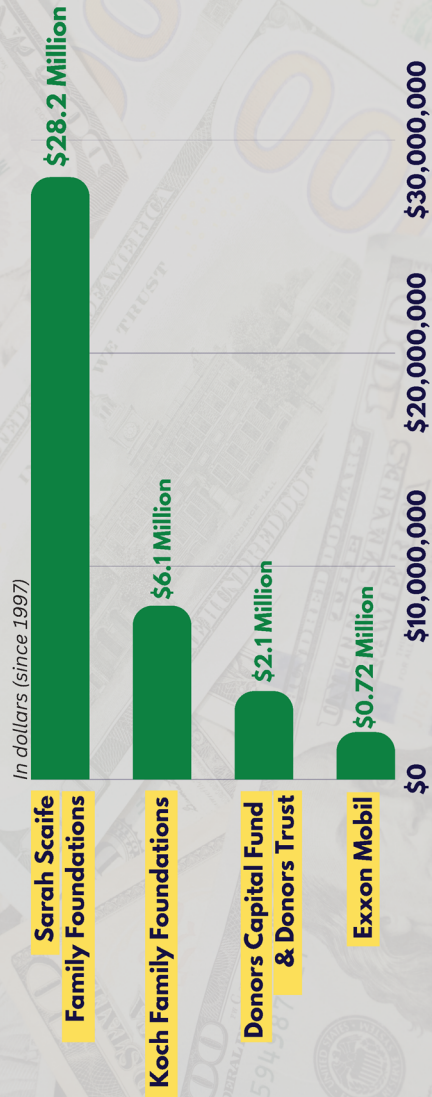
Dear Senator Grassley,

Many thanks for allowing me the opportunity to testify. During my testimony, I spoke only for myself, and not for the Republican Party as a whole. The Republican Party has millions of members, with very different views, and this diversity of thought is valuable as Congress seeks to craft wise public policy.

Sincerely,

Diana Furchtgott-Roth

Heritage Foundation Dark Money & Big Oil Funding



5/3/23, 11:15 AM

Biden-Harris Administration Proposes Strongest-Ever Pollution Standards for Cars and Trucks to Accelerate Transition to a Clean...

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Biden-Harris Administration Proposes Strongest-Ever Pollution Standards for Cars and Trucks to Accelerate Transition to a Clean- Transportation Future

Building on rapid advancements and investments in clean vehicle manufacturing, including investments in domestic manufacturing in the Inflation Reduction Act, EPA's proposed standards would deliver on President Biden's agenda to tackle the climate crisis

April 12, 2023

Contact Information

EPA Press Office (press@epa.gov)

WASHINGTON – Today, the U.S. Environmental Protection Agency (EPA) announced new proposed federal vehicle emissions standards that will accelerate the ongoing transition to a clean vehicles future and tackle the climate crisis. The proposed standards would improve air quality for communities across the nation, especially communities that have borne the burden of polluted air. Together, these proposals would avoid nearly 10 billion tons of CO₂ emissions, equivalent to more than twice the total U.S. CO₂ emissions in 2022, while saving thousands of dollars over the lives of the vehicles meeting these new standards and reduce America's reliance on approximately 20 billion barrels of oil imports.

“By proposing the most ambitious pollution standards ever for cars and trucks, we are delivering on the Biden-Harris Administration's promise to protect people and the planet, securing critical reductions in dangerous air and climate pollution and ensuring significant economic benefits like lower fuel and maintenance costs for families,” **said EPA Administrator Michael S. Regan**. “These ambitious standards are readily achievable thanks to President Biden's Investing in America agenda, which is already driving historic progress to build more American-made electric cars and secure America's global competitiveness.”

Since President Biden took office, the number of EV sales has tripled while the number of available models has doubled. There are over 130,000 public chargers across the country – a 40% increase over 2020. The private sector has also committed more than \$120 billion in domestic EV and battery investments since President Biden signed the Inflation Reduction Act into law. The new standards proposed today reflect the advancements and investments in clean vehicle manufacturing, which have been accelerated by President Biden's Investing in America agenda and complement the ongoing transition in the market towards cleaner vehicles.

The new proposed emissions standards for light-, medium-, and heavy-duty vehicles for model year (MY) 2027 and beyond would significantly reduce climate and other harmful air pollution, unlocking significant benefits for public health, especially in communities that have borne the greatest burden of poor air quality. At the same time, the proposed standards would lower maintenance costs and deliver significant fuel savings for drivers and truck operators.

- Through 2055, EPA projects that the proposed standards would avoid nearly 10 billion tons of CO₂ emissions (equivalent to more than twice the total U.S. CO₂ emissions in 2022). The proposed standards would reduce other harmful air pollution and lead to fewer premature deaths and serious health effects such as hospital admissions due to respiratory and cardiovascular illnesses.
- By accelerating adoption of technologies that reduce fuel and maintenance costs alongside pollution, the proposed standards would save the average consumer \$12,000 over the lifetime of a light-duty vehicle, as compared to a vehicle that was not subject to the new standards.
- Together, the proposals would reduce oil imports by approximately 20 billion barrels.
- Overall, EPA estimates that the benefits of the proposed standards would exceed costs by at least \$1 trillion.

Light- and Medium-Duty Vehicle Proposed Standards

The first set of proposed standards announced today, the "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium Duty Vehicles," builds on EPA's existing emissions standards for passenger cars and light trucks for MYs 2023 through 2026. The proposal retains the proven regulatory design of previous EPA standards for light-duty vehicles, but leverages advances in clean car technology to further reduce both climate pollution and smog- and soot-forming emissions.

Between 2027 and 2055, the total projected net benefits of the light- and medium-duty proposal range from \$850 billion to \$1.6 trillion. The proposal is expected to avoid 7.3 billion tons of CO₂ emissions through 2055, equivalent to eliminating all greenhouse gas emissions from the entire current U.S. transportation sector for four years and would also deliver significant health benefits by reducing fine particulate matter that can cause premature death, heart attacks, respiratory and cardiovascular illnesses, aggravated asthma, and decreased lung function. EPA analysis shows that severe health impacts related to particulate matter exposure will also be reduced – including lung disorders (including cancer), heart disease, and premature mortality.

EPA's proposal considers a broad suite of available emission control technologies, and the standards are designed to allow manufacturers to meet the performance-based standards however works best for their vehicle fleets. EPA projects that for the industry

as a whole, the standards are expected to drive widespread use of filters to reduce gasoline particulate matter emissions and spur greater deployment of CO₂-reducing technologies for gasoline-powered vehicles.

The proposed standards are also projected to accelerate the transition to electric vehicles. Depending on the compliance pathways manufacturers select to meet the standards, EPA projects that EVs could account for 67% of new light-duty vehicle sales and 46% of new medium-duty vehicle sales in MY 2032. The proposed MY 2032 light-duty standards are projected to result in a 56% reduction in projected fleet average greenhouse gas emissions target levels compared to the existing MY 2026 standards. The proposed MY 2032 medium-duty vehicle standards would result in a 44% reduction compared to MY 2026 standards.

Heavy-duty Truck Proposed Standards

The second set of proposed standards announced today, the “Greenhouse Gas Standards for Heavy-Duty Vehicles - Phase 3,” would apply to heavy-duty vocational vehicles (such as delivery trucks, refuse haulers or dump trucks, public utility trucks, transit, shuttle, school buses) and trucks typically used to haul freight. These standards would complement the criteria pollutant standards for MY 2027 and beyond heavy-duty vehicles that EPA finalized in December 2022 and represent the third phase of EPA’s Clean Trucks Plan.

These “Phase 3” greenhouse gas standards maintain the flexible structure that EPA previously designed through a robust stakeholder engagement process to reflect the diverse nature of the heavy-duty industry. Like the light- and medium-duty proposal, the heavy-duty proposal uses performance-based standards that enable manufacturers to achieve compliance efficiently based on the composition of their fleets.

The projected net benefits of the heavy-duty proposal range from \$180 billion to \$320 billion. The proposal is projected to avoid 1.8 billion tons of CO₂ through 2055, equivalent to eliminating all greenhouse gas emissions from the entire current U.S. transportation sector for an entire year, and deliver additional health benefits by reducing other pollutants from these vehicles. The standards would result in improved air quality nationwide, and those who live near major roadways and are

disproportionately exposed to vehicle pollution and heavy-duty activity, which often includes low-income populations and communities of color, would benefit most directly.

Investing in America's Clean Transportation Future

The proposed standards align with commitments made by automakers and U.S. states as they plan to accelerate clean vehicle technologies in the light- and medium-duty fleets in the next 10 to 15 years. Car and truck companies are moving to include electric vehicles as an integral and growing part of current and future product lines, leading to an increasing diversity of clean vehicles for consumers.

These developments are bolstered by President Biden's investments in America, which provide unprecedented resources to support the development and market for clean vehicle technologies and associated infrastructure and represent significant investment in expanding the manufacture, sale, and use of zero-emission vehicles. As these technologies advance, battery costs continue to decline and consumer interest in electric vehicles continues to grow. President Biden's legislative accomplishments are also supporting critical generation of clean electricity and production of clean hydrogen needed to decarbonize transportation. EPA considered this rapid innovation in its assessment that tighter emissions standards are feasible.

EPA's proposals are informed by robust and inclusive stakeholder engagement with industry, labor, advocates, and community leaders. EPA's proposals will be published in the Federal Register and available for public review and comment, and the agency will continue to engage with the public and all interested stakeholders as part of the regulatory development process.

Proposed Rule: Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3
<<https://epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-greenhouse-gas-emissions-standards-heavy>>

Proposed Rule: Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles <<https://epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-multi-pollutant-emissions-standards-model>>

More information on environmental justice and transportation <<https://epa.gov/mobile-source-pollution/environmental-justice-and-transportation>>.



Our Children's Trust
P.O. Box 5181
Eugene, OR 97405

May 02, 2023

Chairman Whitehouse and Ranking Member Grassley, Full Senate Committee on the Budget

Re: Materials for May 03, 2023 Full Committee Hearing on Who Pays the Price: The Real Cost of Fossil Fuels

Dear Chairman Whitehouse and Ranking Member Grassley,

On behalf of Our Children's Trust ("OCT"), a nonprofit law firm dedicated to securing the legal right to a safe climate system for youth and future generations, please find enclosed herewith materials for your consideration relevant to the Senate Committee on the Budget's May 03, 2023 Full Committee Hearing on "Who Pays the Price: The Real Cost of Fossil Fuels." This submission will inspire you with the stories of courageous children and provide resources critical to developing science-based, technically and economically feasible solutions to the climate crisis.

Through youth-led constitutional legal actions, including *Juliana v. United States* ("Juliana") – the landmark federal constitutional climate case filed by twenty-one youth plaintiffs, including eleven Black, Brown and Indigenous youth – OCT supports youth seeking to hold their governments accountable for policies and actions that have caused, and continue to cause, the climate crisis. Through these actions, youth seek science-based remedies to reduce greenhouse gas emissions at rates necessary to protect their fundamental human rights.

It is OCT's understanding that the materials submitted for the May 3rd hearing will inform the Committee's outlook on how to best shape future climate policy and legislation pertaining to solutions that decrease emissions. Given our mission, OCT has a substantial interest in ensuring that any such legislation is consistent with what the best available science dictates is necessary to stabilize the climate system and protect the fundamental rights of youth and future generations.





We invite you to consult the materials enclosed herewith, which demonstrate that climate change is *already harming* the fundamental rights of young people in the United States and **legislation which ensures emissions reductions and sequestration of excess carbon dioxide (CO₂) is necessary for the protection of the fundamental rights of American children.**

Specifically, enclosed as **Exhibit A** is a summary and status of the *Juliana* case, including some profiles of the diverse plaintiffs. Two reports are from expert witnesses in *Juliana*. Enclosed as **Exhibit B** is the expert report of Joseph Stiglitz, Ph.D., an economist and professor at Columbia University. This expert report discusses the economics of transitioning to a non-fossil fuel economy, in particular, how climate change will harm youth from an economic perspective if the U.S. federal government continues to pursue policies that perpetuate a fossil-fuel-based energy system and defer action to mitigate climate change, and economic benefits of transitioning to a non-fossil-fuel economy now rather than later. Stiglitz states:

First, despite their relative lack of economic power in society today, Youth Plaintiffs themselves will suffer the disproportionate, increased financial burdens of climate change as the impacts of climate change propagate throughout the economy.

Second, Youth Plaintiffs and Affected Children will face increased burdens as taxpayers because, as Defendants and climate scientists project, climate change will increase future losses related to climate variability, sometimes of a catastrophic nature.

Third, Youth Plaintiffs will face increased burdens because the more time that passes, the more expensive it becomes to address climate change.

Fourth, in the absence of mitigation efforts, there is a significant risk of catastrophic impacts of climate change; indeed, there is overwhelming evidence that such catastrophic impacts are likely to result.

Enclosed as **Exhibit C** is the expert report of Frank Ackerman, Ph.D. (Principal Economist, Synapse Energy Economics; now deceased). Dr. Ackerman's expert report discusses the economic consequences of human-caused climate change and the economic feasibility of a swift transition off of fossil fuels for energy. The report articulates the multiple reasons why conventional economic analyses undervalue or dismiss the serious risks of climate damages including: standard approaches to discounting, the treatment of extreme risks and irreversible losses, reliance on flawed techniques of cost-benefit analysis, use of limited and often biased damage estimates, and specific choices made in calculating the "social cost of carbon." Ackerman states:



- The costs of solving the climate crisis are falling rapidly. In contrast to the risks of catastrophic changes in the earth's climate system and the ever-increasing damages and costs from the present inaction of government that perpetuates climate pollution, the costs of renewable energy technologies to reduce emissions have been plunging downward in recent years. It is now much cheaper than anyone expected just a decade ago to substitute carbon-free energy for fossil fuels.
- If our impacts on future generations matter, then the appropriate discount rate for climate costs and benefits needs to be very low, probably near zero, an argument made effectively in the Stern Review (Stern 2007), and other sources.

Enclosed as **Exhibit D** you will find a document entitled "Government Climate and Energy Policies Must Target <350 ppm Atmospheric CO₂ by 2100 to Protect Children and Future Generations." This document details the scientific basis underlying, and prescription for, stabilization of the climate system as necessary to protect the fundamental human rights of youth and future generations relative to the climate crisis and explains the scientific basis that warming of up to 1.5°C is *not safe*, as the IPCC has also acknowledged.

Climate policy and legislation which ensure emissions reductions and sequestration of excess CO₂ consistent with what the best available science dictates is necessary for the protection of the fundamental rights of young people and future generations. The information in these exhibits are additionally relevant to a forthcoming reintroduction of a Senate concurrent resolution, Children's Fundamental Rights and Climate Recovery, sponsored by Senator Merkley, supporting the *Juliana* youth plaintiffs. It recognizes the disproportionate effects of the climate crisis on children and their health, economic opportunity, and fundamental rights which demands U.S. leadership and the development of a national, science-based, and just climate recovery plan. The resolution, [S Con Res 8](#), reintroduced in April 2021, had the support of 65 members from both chambers.

Should you have any questions regarding the enclosed materials, please feel free to contact Liz Lee, OCT's government affairs staff attorney at liz@ourchildrenstrust.org.

Sincerely,

/s/ Julia Olson
 Julia Olson
 Executive Director
 Our Children's Trust



**Enclosures:**

Exhibit A: *Juliana v. United States* Summary and Plaintiffs' Profiles

Exhibit B: Expert Report of Joseph E. Stiglitz, Ph.D.

Exhibit C: Expert Report of Frank Ackerman, Ph.D.

Exhibit D: Government Climate and Energy Policies Must Target <350 ppm Atmospheric CO₂ by 2100 to Protect Children and Future Generations (April 2023)

Exhibit A:

Juliana v. United States Summary
and Plaintiffs' Profiles



Juliana v. United States

Young Americans Fight for Their Constitutional Rights and Climate Recovery

Background

Represented by attorneys at [Our Children's Trust](#), **21 young Americans, including 11 Black, Brown, and Indigenous youth, filed their constitutional climate lawsuit, *Juliana v. United States*, against the executive branch of the U.S. government in 2015.** They assert that the government's affirmative actions causing climate change have violated their constitutional rights to life, liberty, property, and equal protection of the laws, and impaired essential public trust resources. The youth are supported by a team of scientific experts who explain that atmospheric carbon dioxide levels must be reduced to below 350 parts per million (ppm) by 2100, which would bring long-term heating of the Earth back down to ~1.0° C above preindustrial temperatures, stabilizing the climate. Renowned energy experts published a 2019 [report](#) and 2020 Florida [report](#), that includes updated U.S. data, that demonstrates the technical and economic viability of the U.S. returning to 350 ppm by 2100.

History

The U.S. District Court has repeatedly found that the youth plaintiffs have legitimate claims for trial. **In a ground-breaking decision in November 2016, the court found that the U.S. Constitution secures the fundamental right to a climate system capable of sustaining life;** that plaintiffs' injuries give them standing to bring their claims; and that the Court has authority to remedy the youth's injuries. Since that historic ruling, the defendants have relentlessly attempted to prevent *Juliana v. U.S.* from going to trial. Four times in the Ninth Circuit Court of Appeals and twice in the U.S. Supreme Court, the courts ruled in favor of the youth.

On January 17, 2020, a divided panel of the Ninth Circuit Court of Appeals found for the plaintiffs in nearly every respect, but narrowly ruled that Federal courts cannot stop the executive branch of government from harming children with its policies that cause climate change. To address the concerns of the Ninth Circuit, on March 9, 2021, plaintiffs requested to amend their complaint in the U.S. District Court seeking a declaration that the U.S. fossil fuel energy system is unconstitutional and violates their fundamental right to a safe climate. On May 13, 2021, District Court Judge Aiken ordered the parties to engage in settlement discussions. Oral argument on the motion to amend was held on June 25, 2021 and the **plaintiffs are awaiting a ruling.** On July 6, 2021, attorneys general from New York, Delaware, Hawai'i, Minnesota, Oregon, and Vermont **filed an amicus brief** in solidarity with the plaintiffs' opposition to the attorneys general from 18 republican states that sought intervention into the case. The judge **denied** the request to intervene and granted the amicus brief on March 14, 2023. **The Biden administration and the Department of Justice now have a renewed opportunity to create a lasting legacy by enshrining science-based climate protection as a fundamental right for children and generations to come.**

Support These Brave Youth Plaintiffs

Please publicly support the youth plaintiffs' right to have their constitutional claims upheld in a court of law. Support the forthcoming congressional resolution recognizing children's fundamental rights and the need for a national, science-based climate recovery plan (Prior: ourchildrenstrust.org/congressional-resolution-2021). Also, join future letters and *amicus curiae* briefs in support of their constitutional rights and the judiciary exercising its Article III powers in their case. Twenty-four members filed a [brief](#) in March 2020 in the Ninth Circuit and 48 members signed [letters](#) to President Biden in November 2021. **Show our Nation's children your commitment to their future, and the future of all generations.**

info@ourchildrenstrust.org | www.ourchildrenstrust.org



Juliana v. United States: Meet the Plaintiffs

Meet all 21 Juliana plaintiffs at ourchildrenstrust.org/federal-plaintiffs.
 Learn more about their stories in this [60 minutes segment](https://bit.ly/60minsjuliana) (bit.ly/60minsjuliana) and their
 visit to Congress in [this video](https://bit.ly/yearsprojectjuliana) (bit.ly/yearsprojectjuliana) from The YEARS Project

For over seven years, these diverse, young plaintiffs, all of whom have been personally harmed by the climate crisis, have been leading the game-changing litigation campaign to secure the legal right to a safe climate system for young people, based on the best available science. In 2015, they filed their constitutional climate lawsuit against the U.S. government in the U.S. District Court for Oregon.



Kelsey Juliana, 26, Eugene, OR

Fighting climate change since she was 10, Kelsey has been increasingly exposed to hazardous wildfire smoke in her hometown. As a teenager, she participated in the Great March for Climate Action, marching 1,600 miles from Nebraska to D.C. Time Magazine recognized Kelsey as a Rising Star in its list of the Next 100 Most Influential People in the World.



Vic Barrett, 23, White Plains, NY

A Garifuna American, Vic has spoken about environmental justice issues and how his climate anxiety is increased because his identities — first generation, trans, Indigenous, Latinx, Black, youth — make him uniquely vulnerable to the climate crisis. In 2019, he testified at a historic joint hearing of the House Foreign Affairs and Select Committee on the Climate Crisis alongside Greta Thunberg.



Jaime Butler, 22, Flagstaff, AZ

Jaime is of the Tangle People Clan, born of the Bitterwater Clan. She grew up in Cameron, Arizona on the Navajo Nation Reservation, but had to move due to water scarcity and failed attempts at dryland farming. Jaime knows firsthand the cultural and spiritual impacts of the climate crisis as she and her tribe struggle to participate in their traditional ceremonies due to climate-related impacts.



Levi Draheim, 15, Satellite Beach, FL

Levi has lived most of his life on a barrier island in Florida, barely above sea level and literally washing away due to sea level rise and storms made worse by climate change. In 2019, Levi addressed a youth stakeholder's meeting with members of the Senate Democrats' Special Committee on the Climate Crisis at the United Nations Foundation. His younger sister is a source of motivation and inspiration.



Xiuhtezcatl Martinez, 22, Boulder, CO

Xiuhtezcatl is a renowned hip-hop artist and activist. He is also the former Youth Director and Co-Chair of the executive board for Earth Guardians. He has experienced extreme weather events that have been exacerbated due to climate change, such as catastrophic flooding. Raised in the Aztec tradition, Xiuhtezcatl has spoken at the United Nations several times, including in English, Spanish, and his Native language, Nahuatl.

info@ourchildrenstrust.org | www.ourchildrenstrust.org

Exhibit B:

Expert Report of Joseph E. Stiglitz, Ph.D.

**EXPERT REPORT
OF
JOSEPH E. STIGLITZ, PH.D.**

University Professor, Columbia University

Kelsey Cascadia Rose Juliana; Xiuhtezcatl Tonatiuh M.,
through his Guardian Tamara Roske-Martinez; et al.,
Plaintiffs,

v.

The United States of America; Donald Trump,
in his official capacity as President of the United States; et al.,
Defendants.

IN THE UNITED STATES DISTRICT COURT
DISTRICT OF OREGON

(Case No.: 6:15-cv-01517-TC)

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TABLE OF ACRONYMS AND ABBREVIATIONS

C:	Celsius
CAFE:	Corporate Average Fuel Economy
CAD:	Canadian Dollar
CBO:	Congressional Budget Office
CO ₂ :	carbon dioxide
CPI:	consumer price index
EPA:	U.S. Environmental Protection Agency
GDP:	gross domestic product
GHGs:	greenhouse gases
IMF:	International Monetary Fund
IPCC:	Intergovernmental Panel on Climate Change
NASA:	National Aeronautics and Space Administration
NOAA:	National Oceanic and Atmospheric Administration
OECD:	Organisation for Economic Co-operation and Development
OMB:	Office of Management and Budget
ppm:	parts per million
R&D:	research and development
USGCRP:	U.S. Global Change Research Program

I. QUALIFICATIONS AND PROFESSIONAL BACKGROUND

1. I am one of sixteen University Professors at Columbia University with joint appointments in the Faculty of Arts and Sciences (Department of Economics), the Graduate School of Business (Department of Finance), and the School of International and Public Affairs. Prior to assuming this position, I held professorships at Stanford University, Yale University, Princeton University, and the University of Oxford, where I taught a wide variety of graduate and undergraduate courses in economics and finance. I received my Ph.D. in Economics from MIT in 1967.
2. Over the course of my career I have published hundreds of peer-reviewed articles, written or edited more than 50 academic and popular books, testified several times before Congress, and written numerous opinion pieces for newspapers and magazines. My publications and research have extended into many different areas, including macroeconomics and monetary theory, development economics and trade theory, public and corporate finance, industrial organization and rural organization, welfare economics, and income and wealth distribution, many of which are germane to this case. Oxford University Press is in the process of publishing a six-volume set based on my research, *Selected Works of Joseph E. Stiglitz*. The first two volumes have been published and are entitled *Information and Economic Analysis: Basic Principles and Information* and *Economic Analysis: Applications to Capital, Labor, and Products Markets*.
3. Public economics and public finance, which study how governments raise funds and make expenditures, have been major pillars of my academic work. I served as a co-editor of the *Journal of Public Economics*, the leading economics journal dealing with matters of taxation and public economics, and have published broadly in this area. My textbook, *Economics of the Public Sector*, is a leading text first published in 1986 with the most-recent version released in 2015. Another of my books, *Lectures on Public Economics*, published in 1980 and reprinted in 2015 with a new introduction, has been widely translated. Many of my popular texts, including my recent books *The Great Divide* and *The Price of Inequality*, published in 2015 and 2012, respectively, critically examine our public institutions, and comment on public finance and public economics generally.

4. Environmental economics and economic policy around natural resources has been another focus of my academic and professional work. I was one of the lead authors of the 1995 Report of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with former Vice President Gore. I was co-chair of the High-Level Commission on Carbon Prices (we released our report in May 2017). I was also involved in environmental economic policy during my time on the Council of Economic Advisors, where one of my responsibilities was evaluating, designing, and implementing public policies that affect the environment, and while Chief Economist of the World Bank, where one of my responsibilities was evaluating and designing environmentally sustainable economic policies. I have also published many peer-reviewed articles that examine how we treat externalities (e.g., pollution) and public goods (e.g., the environment).
5. I have received numerous fellowships and honors over my career. In 2001, I was awarded the Nobel Memorial Prize in Economics for my work on Information Economics. This work includes the study of how information asymmetries affect economic behavior, the determination of the conditions under which efficient sharing of risk occurs, and the economics of financial markets, which are directly relevant to this case. In 1979, I was awarded the John Bates Clark Medal by the American Economic Association, given biennially to the economist under 40 who has made the most significant contribution to economics.¹
6. I was the founding editor of the *Journal of Economic Perspectives*. I have served (or am currently serving) on the Editorial Board of numerous journals, including *The Economists' Voice*, the *Journal of Globalization and Development*, the *World Bank Economic Review*, the *Journal of Public Economics*, the *American Economic Review*, the *Journal of Economic Theory*, *The Review of Industrial Organization, Managerial and Decision Economics*, *Energy Economics*, the *Review of Economic Design*, and the *Review of Economic Studies*.

¹ The John Bates Clark Medal has been given annually since 2009.

7. I served as President of the International Economic Association from 2011–2014 and as President of the Eastern Economic Association in 2008. I also served as Vice President of the American Economic Association in 1985.
8. I have received more than 40 honorary degrees, and have received awards from foreign governments, including the Legion of Honor from France. I have also been elected to numerous academic and scientific societies in the United States and abroad, including the National Academy of Sciences, the Royal Society, the American Academy of Arts and Sciences, the American Philosophical Society, and the British Academy. In 2011, *Time* magazine named me to their *Time 100* list as one of the 100 most influential people in the world.
9. From 1993 to 1997, I served as a member of President Clinton’s Council of Economic Advisers, and from 1995 to 1997, as Chairman of the Council and a member of the President’s Cabinet. As Chairman and Cabinet Member, I was heavily involved in formulating fiscal policy, sustainable economic policies (including environmental economic policies), financial sector regulation and banking policy, and coordinating policy with the U.S. Treasury.
10. From 1997 to 2000, I served as Chief Economist and Senior Vice President of the World Bank, in which capacity I had the responsibility of advising countries around the world on the design of fiscal, tax, and monetary policies, competition policies, sustainable economic policies (including those regarding natural resources and the environment), intellectual property regimes, financial regulations, and trade policy.
11. I have served or am serving currently on many commissions and advisory committees addressing a myriad of economic policy issues, both in the U.S. and abroad, including the Joint CFTC-SEC Advisory Committee on Emerging Regulatory Issues, the United Nations’ International Labour Organization World Commission on the Social Dimensions of Globalization, the High Level Panel of the African Development Bank, and the Economic Advisory Panel in South Africa.
12. At the behest of the President of the General Assembly of the United Nations, I served as Chair of the Commission of Experts on Reforms of the International Monetary and Financial System, to review the workings of the global financial system in the wake of

the 2008 economic crisis and suggest steps for U.N. member states to secure a sustainable economic future. Our final report was published in September 2009. In addition, I was appointed President of the Commission on the Measurement of Economic Performance and Social Progress by President Sarkozy of France, in 2008. This commission was formed to consider flaws in traditional macroeconomic indicators measuring economic performance and social progress and consider what might be the more relevant metrics, which are relevant to this case. Our final report was released in September 2009.

13. In 2000, I founded the Initiative for Policy Dialogue, for which I continue to serve as co-President. The Initiative for Policy Dialogue is a global network of academics and practitioners to enhance democratic processes for decision-making in developing countries. I am also Co-Chair of the High-Level Expert Group on the Measurement of Economic Performance and Social Progress, Organisation for Economic Co-operation and Development (OECD) and the Chief Economist of, and a Senior Fellow at, the Roosevelt Institute.
14. Previously, I served as Chair of the Management Board at the Brooks World Poverty Institute at the University of Manchester, on the Board of Trustees of Amherst College, my undergraduate *alma mater*, and as Co-Chair of Columbia University's Committee on Global Thought.
15. I have provided expert testimony in various fora throughout the United States, and before foreign courts and international tribunals. I have submitted *amicus curiae* briefs before the Supreme Court of the United States and before U.S. Circuit Courts of Appeal. My expert testimonies have related broadly to financial markets and derivatives, taxes, antitrust and competition, patent enforcement, and public interest generally (e.g., promotion of efficiency and/or minimization of welfare costs). I have also offered testimony regarding environmental economics, specifically, around offshore drilling.
16. My curriculum vitae, which provides more details of my qualifications, including a list of my publications, is attached as **Exhibit A**. **Exhibit B** contains a list of my previous expert testimony within the last five years. The materials that I, and volunteers supporting me at my direction, considered in preparing this report are cited in the footnotes and listed in **Exhibit C**.

17. I am working *pro bono* to prepare this expert report. My usual rate for work in litigation matters is \$2,000 per hour, which is the rate I will charge if another party seeks discovery under Federal Rule 26(b). I have no present or intended financial interest in the outcome of this matter. My work in this matter is ongoing, and I reserve the right to revise or augment the opinions set forth in this report should additional relevant information become available to me, or as I perform further analysis.

II. ASSIGNMENT AND SUMMARY OF CONCLUSIONS

18. Julia Olson and Philip Gregory, counsel for Plaintiffs in this matter, have asked me to provide my expert opinion on the economics of transitioning to a non-fossil fuel economy.² In particular, I have been asked: (a) to analyze from an economic perspective how climate change will harm the Youth Plaintiffs (and Affected Children) if Defendants continue to pursue policies that perpetuate a fossil-fuel-based energy system and defer action to mitigate climate change; and (b) to assess the economic benefits of transitioning to a non-fossil-fuel economy now rather than later. The opinions expressed in this report are my own. All opinions expressed herein are to a reasonable degree of scientific certainty, unless otherwise specifically stated.
19. I have formed four primary conclusions in this case, the bases for which are set forth more fully below:
- a. Scientific evidence shows further incremental increases in global temperature will lead to disproportionately greater costs imposed on our society. This has important consequences for how Defendants' actions harm the Youth Plaintiffs and Affected Children more generally. Continuation of the national fossil fuel-based energy system by Defendants is causing imminent, significant, and irreparable harm to the Youth Plaintiffs and Affected Children more generally. This kind of environmental harm, by its nature, cannot be adequately remedied by money damages and is often permanent or at least of long duration, i.e., irreparable. There is a point at which, once this harm occurs, it cannot be undone at any reasonable cost or in any reasonable period of time. Based on the best available science, our country is close to approaching that point.³

² I understand that the plaintiffs in this litigation are young people, who I will refer to as the "Youth Plaintiffs." However, my analysis also looks at the impact on other young people who are not named plaintiffs (and as-yet-unborn youth, the so-called future generations), but are just as (or even more) affected, whom I collectively refer to as "Affected Children."

³ This is a global problem. However, as I discuss below in Section V.B, the U.S. is a significant contributor to GHG emissions, and so actions by the U.S., have a significant impact on these global outcomes.

- b. Defendants' continuing support and perpetuation of a national fossil fuel-based energy system and continuing delay in addressing climate change is saddling and will continue to saddle Youth Plaintiffs with an enormous cost burden, as well as tremendous risks, which is causing substantial harm to the economic and personal well-being and security of Youth Plaintiffs. These costs and risks will be borne over each ensuing year that progress towards remediation is not undertaken by Defendants. Such costs and risks arise both from damage caused by accumulated greenhouse gas emissions and from the required outlays on future remediation and adaptation efforts, which grow more expensive as the accumulation of greenhouse gases in the atmosphere increases. There are particularly consequential risks arising from the potentially catastrophic impacts of climate change, which increase each year that Defendants defer action on greenhouse-gas mitigation efforts.
- c. Moving the U.S. economy away from fossil fuels is both feasible and beneficial, especially over the next 30 years (as technological and scientific evidence discussed below makes clear). Defendants could facilitate this transition with standard economic tools for dealing with externalities, for example a tax or levy on carbon (a price on the externality) and the elimination of subsidies on fossil-fuel production. Relatedly, decisions concerning the transition off of fossil fuels can be reached more systematically and efficiently by revising current government discounting practices, the methodology by which future costs are compared to present costs. Current and historical government decision making practices based on incorrect discount rates lead to inefficient and inequitable outcomes that impose undue burdens on Youth Plaintiffs and future generations. Basing decisions (policies, programs, and actions) on appropriate discount rates would help minimize the burdens that Defendants' current policies place on Youth Plaintiffs and future generations. That is to say, if Defendants' discounting policies and practices more accurately reflected the expected changes in relative prices over time (and their distribution, implicitly putting a lower discount rate on climate change benefits), the basis for Defendants' policy-making decisions would more closely align with economic principles and yield more efficient outcomes.

- d. Based on this reasoning, I conclude that Defendants can and should take meaningful actions to reduce GHG emissions from fossil fuels and mitigate climate change impacts now rather than defer action to some future date. Acting now will yield benefits for both Defendants and Youth Plaintiffs and reduce harm to Youth Plaintiffs, and the costs of mitigating climate change now are manageable. Defendants could make meaningful progress on climate change mitigation by acting today in accordance with the best available science. Moreover, Defendants meeting their constitutional and public trust obligations to redress climate change would improve societal well-being by any reasonable economic standard. In fact, some of the actions that Defendants could take to meet these obligations would actually have a negative cost. That is to say, in the long run, the net present value of benefits to society would exceed the net present value of costs that society would have to incur.⁴ This is referred to as Kaldor–Hicks efficiency in standard economic analysis, typically a hallmark of sound policymaking, from an economic perspective, whereby the net benefits of a policy change outweigh the net costs of such policy change. Thus, if Defendants were to make such changes as are argued for by other of Plaintiffs’ experts, the net societal gain would more than outweigh the net societal loss. In contrast, Defendants’ current policies of perpetuating the fossil fuel-based energy system impose unacceptably high costs and risks on the Youth Plaintiffs specifically and Affected Children more generally, and will continue to do so, well out of portion to the amounts that Defendants save currently by avoiding taking the appropriate actions.
20. The body of my report sets out the factual and analytical bases for my conclusions and opinions. The balance of my report proceeds as follows: Section III summarizes the scientific evidence on increasing greenhouse gases affecting global temperatures and why the time to act is now; Section IV discusses the costs that Youth Plaintiffs will face if Defendants continue to promote and permit a fossil-fuel-based energy system and no

⁴ This is not to say that each party is better off (which would be a Pareto improvement); but those parties who are better off by the policy change (e.g., non-polluters) are made better off by more than the parties made worse off by the policy change (e.g., polluters) are made worse off.

actions (or insufficient actions) are taken to wean society off fossil fuels; Section V analyzes how the transition away from fossil fuels is feasible and can be facilitated with standard economic tools; and, finally, Section VI concludes.

III. BACKGROUND ON THE RELATIONSHIP BETWEEN ATMOSPHERIC CONCENTRATIONS OF GREENHOUSE GASES AND CLIMATE CHANGE

21. The climate change young people are experiencing today is caused by the historic emissions of carbon dioxide (CO₂) and other greenhouse gases (GHGs), primarily from burning fossil fuels and other anthropogenic activities, including deforestation and agricultural practices.⁵ It is scientifically established that human activities produce GHG emissions, which accumulate in the atmosphere and the oceans, resulting in warming of Earth's surface and the oceans⁶, acidification of the oceans,⁷ increased variability of climate, with a higher incidence of extreme weather events, and other changes in the climate.
22. Dangerous impacts are already occurring from the current level of global warming of around 1°C above preindustrial temperatures. Climate scientists have established through the paleo record that warming of 1.5°C or 2°C above pre-industrial levels would be well outside the Holocene range of global temperatures within which humans have lived and

⁵ See, for example, Intergovernmental Panel on Climate Change, "Climate Change 2014: Synthesis Report Summary for Policymakers," pp. 4-5. Other Greenhouse Gases, like Methane, also trap heat within the earth. They differ in key technical properties, like the rate of dissipation. Throughout this report, I use the terms GHG and CO₂ emissions interchangeably.

There is a popular but misguided debate among so-called climate "skeptics" about the extent to which the observed increase in temperature is a result of the emissions of CO₂ and other GHGs. The scientific literature is clear (and has been clear for a long time): the increase in atmospheric concentration of GHGs predictably increases the Earth's temperature in the manner observed. This has been most recently reaffirmed by "Climate Science Special Report: Fourth National Climate Assessment, Volume I" U.S. Global Change Research Program, November 2017, pp. 96-97 https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf. (Hereinafter USGCRP Climate Science Special Report).

But even if there were other factors contributing to climate change, the analysis here is unchanged: Defendants could, with mild costs, take actions now that would avoid imposing the undue and excessive burdens and risks imposed on the Youth Plaintiffs in this case.

⁶ USGCRP Climate Science Special Report, p. 364.

⁷ USGCRP Climate Science Special Report, pp. 371-372.

societies developed.⁸ Moreover, leading experts believe that there is already more than enough excess heat in the climate system to do severe damage and that 2°C of warming would have very significant adverse effects, including resulting in multi-meter sea level rise.⁹ NOAA projects up to 0.63 m (2.1 feet) of sea level rise by 2050, 1.2 m (3.9 feet) by 2070, 2.5 m (8.2 feet) by 2100, 5.5 m (18 feet) by 2150, and 9.7 m (31.8 feet) by 2200.¹⁰ A 2-3 foot sea level rise would inundate and render uninhabitable large portions of the world's barrier islands and deltas and place major pressures on the infrastructure of low-lying coastal zones like South Florida, and 3 feet of sea level rise would "permanently inundate 2 million American's homes and communities."¹¹ Sea level rise of this magnitude would impose irreversible harm and an immense financial burden on young people in coastal areas, along with significant indirect costs on young people elsewhere.

23. Experts have identified a number of known "feedback loops" in the climate system. These feedback loops cause warming to catalyze still further warming. For example, warmer arctic temperatures result in melting permafrost that releases methane, a GHG that further warms the planet. These feedbacks, in conjunction with the fact that CO₂ persists in the atmosphere for centuries, mean that the longer we delay action, the greater the risk that warming will trigger tipping points in the climate system and become irreversible, or reversible only at much increased cost. Given the self-reinforcing nature

⁸ J. Hansen et al., "Assessing 'Dangerous Climate Change': Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature," *PLOS One*, 8:12, e81648, 2013, p. 9.

⁹ J. Hansen, et al., "Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2C global warming is highly dangerous," *Atmospheric Chemistry and Physics Discussions*, 15, 20059-179, 2015, <http://faculty.sites.uci.edu/crignot/files/2017/06/Ice-melt-sea-level-rise-and-superstorms-evidence-from-paleoclimate-data-climate-modeling-and-modern-observations-that-2C-global-warming-is-highly-dangerous.pdf>.

¹⁰ "Global and regional sea level rise scenarios for the United States," NOAA Technical Report NOS CO-OPS 083, January 2017, p. 23, https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf.

¹¹ H. Wanless, "Declaration of Dr. Harold R. Wanless in Support of Answer of Real Parties in Interest to Petition for Writ of Mandamus", in *United States of America et al. v. United States District Court for the District of Oregon et al.*, Case No. 17-71692, Doc. No. 14-3, paras. 31-32, citing "Global and regional sea level rise scenarios for the United States," NOAA Technical Report NOS CO-OPS 083, January 2017.

of climate change, prompt action is needed to both minimize future emissions and reduce the effects of historic emissions.

24. Experts have observed an increased incidence of climate-related extreme weather events, including increased frequency and intensity of extreme heat and heavy precipitation events and more severe droughts and associated heatwaves. Experts have also observed an increased incidence of large forest fires; and reduced snowpack affecting water resources in the western U.S. The most recent National Climate Assessment projects these climate impacts will continue to worsen in the future as global temperatures increase.¹²
25. Although the scale of the problems and risks that we face are immense, it is possible to reduce these risks by acting now to avoid irreversible harm to essential natural systems with its catastrophic consequences such as sea level rise, increased ocean temperatures, ocean acidification, heat waves, increased drought, and the associated impacts on water quality and availability, human health, and agriculture. Such impacts would harm our economy directly and introduce much increased risk in the form of variability in and uncertainty around climate outcomes.
26. Dr. Hansen and other experts in this case have provided a prescription for an emissions reduction and carbon sequestration pathway back to CO₂ levels below 350 ppm by 2100, which they say would substantially lessen the risk of catastrophic sea level rise and other climate harms.¹³ Returning to temperatures and atmospheric CO₂ levels that avoid dangerous anthropogenic climate change has a limited window (because of tipping points in the climate system), which is still open but is closing rapidly. Defendants must take action now to reduce these risks.

¹² USGCRP Climate Science Special Report, pp. 19-22.

¹³ James Hansen et al., “Assessing ‘Dangerous Climate Change’: Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature,” *PLOS One*, 8:12, e81648, 2013.

IV. DEFENDANTS' ACTIONS THAT PERPETUATE A FOSSIL FUEL ENERGY SYSTEM AND INSUFFICIENT ACTION ON CLIMATE CHANGE ARE IMPOSING AND WILL CONTINUE TO IMPOSE ENORMOUS COSTS ON YOUTH PLAINTIFFS

27. The current national energy system, in which approximately 80 percent of energy comes from fossil fuels, is a direct result of decisions and actions taken by Defendants.¹⁴ Defendants control and dictate the U.S. national energy policy in a myriad of ways. For example, they provide billions of dollars annually in subsidies to the fossil fuel industry;¹⁵ control the fuel economy of cars and trucks through the Corporate Average Fuel Economy (“CAFE”) standard; set efficiency standards for appliances; permit the extraction, transportation, import, export, and combustion of fossil fuels; and provide funding for research and development.¹⁶ The fact that the U.S. national energy system is so predominately fossil fuel-based is not an inevitable consequence of history. With the oil crises of the 1970s, recognition of the risks of dependence on oil was developed (though these risks were markedly different from those with which we are concerned today). Even then, it was clear that there were viable alternatives, and with the appropriate allocation of further resources to R&D, it is likely that these alternatives would have been even more competitive. Thus, the current level of dependence of our energy system on fossil fuels is a result of intentional actions taken by Defendants over many years (including subsidization of fossil fuels and *inactions* in the form of not providing adequate support for alternatives).¹⁷ Cumulatively, these actions promote the use of fossil fuels, contribute to dangerous levels of CO₂ emissions, and cause climate change. The economic impacts of these actions are deleterious to Youth Plaintiffs and the nation as a whole. In other words, Defendants’ actions promoting a fossil fuel based

¹⁴ U.S. Energy Information Administration, Table 1.3 Primary Energy Consumption by Source, August 2017 Monthly Energy Review, <https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T01.03&freq=m>.

¹⁵ See, Section V, below.

¹⁶ “Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013”, U.S. Energy Information Administration, March 2015, <https://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf>.

¹⁷ I would note that inactions in this sense are affirmative decisions by Defendants not to act.

energy system are serving to undermine the legitimate government interests of national security and economic prosperity that they purport to advance.¹⁸

28. When conducting an economic analysis of the effects of climate change and appropriate responses thereto, Defendants must take into account a number of salient aspects of climate change. I have already noted some of these aspects: not just global warming in the sense of on-average increases in temperature, but also an increase in extreme (and damaging) weather events, rising sea levels, the public health consequences, and many other direct and indirect impacts of climate change. Still another aspect of climate change that is crucial in framing an appropriate response are the long lag times inherent in the climate system, implying that the full climate impact of any given accumulation of GHGs may not be apparent for many years.¹⁹ Moreover, critical to the effects (as already noted) is the increase in concentration of GHGs. The fact that GHGs dissipate very slowly from the atmosphere (particularly in the case of CO₂²⁰) and that the costs of taking

¹⁸ Daniel R. Coats, Director of National Intelligence, “Statement for the Record: Worldwide Threat Assessment of the US Intelligence Community,” *Office of the Director of National Intelligence*, February 13, 2018, <https://www.intelligence.senate.gov/sites/default/files/documents/os-decoats-021318.PDF> (at page 16: “The impacts of the long-term trends toward a warming climate, more air pollution, biodiversity loss, and water scarcity are likely to fuel economic and social discontent—and possibly upheaval....”).

¹⁹ Because of these lags, we have not yet seen the full rise in temperature that will occur as a result of the CO₂ that has already been emitted. As noted above, the Earth’s average surface temperature has already risen by approximately 1°C since the Industrial Revolution. The concentration of CO₂ in the atmosphere is increasing at the rate of 2-3 ppm per year. Scientists tell us that even if CO₂ were stabilized at current levels, there would be at least another 0.5°C “in the pipeline.” The delayed response is known as climate lag. The reason the planet takes several decades to respond to increased CO₂ is the thermal inertia of the oceans. Consider a saucepan of water placed on a gas stove. Although the flame has a temperature measured in hundreds of degrees C, the water takes a few minutes to reach boiling point. This simple analogy explains climate lag. The mass of the oceans is around 500 times that of the atmosphere. The time that it takes to warm up is measured in decades. For example, a paper by Dr. Hansen (and others) estimates the time required for 60 percent of global warming to take place in response to increased emissions to be in the range of 25 to 50 years. See, Hansen, J.E. et al., “Earth’s Energy Imbalance: Confirmation and Implications,” *Scienceexpress*, April 28, 2004, <http://science.sciencemag.org/content/early/2005/04/28/science.1110252>.

²⁰ Accumulations of CO₂ are particularly problematic because they dissipate so slowly. See, e.g., “Carbon is forever,” *Nature Reports Climate Change*, November 20, 2008. This article discusses results from Dr. Hansen’s research, stating: “Several long-term climate models, though their details differ, all agree that anthropogenic CO₂ takes an enormously long time to dissipate. If all recoverable fossil fuels were burnt up using today’s technologies, after 1,000 years the air would still hold around

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CO₂ out of the atmosphere through non-biological carbon capture and storage are very high²¹ means that the consequences of GHG emissions should be viewed as effectively irreversible. Accordingly, if Defendants do not take serious action to mitigate climate change now, Youth Plaintiffs and Affected Children will largely shoulder the costs caused by Defendants' actions that contribute to the further accumulation of GHGs and Defendants' failure to act to redress the harm. We can expect these burdens to manifest themselves in at least four ways.

29. *First*, despite their relative lack of economic power in society today, Youth Plaintiffs themselves will suffer the disproportionate, increased financial burdens of climate change as the impacts of climate change propagate throughout the economy. For example, rising sea levels will lead to massive reductions in property value (indeed, the value of land that is underwater will fall to zero). Some Youth Plaintiffs, such as Levi D., and Affected Children will (with high probability) be deprived of the use of submerged lands, and many of them will almost surely experience large capital losses, as markets eventually fully reflect the realities of climate change. In addition, Youth Plaintiffs and Affected Children will, as future taxpayers, help bear the enormous cost of relocating the people and infrastructure that are now on this land to higher ground. Youth Plaintiffs and Affected Children will also bear the cost of instituting temporary stopgap measures, such as dikes to hold back rising sea levels, and some of them will have to bear directly themselves relocation costs.

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a third to a half of the CO₂ emissions. 'For practical purposes, 500 to 1000 years is 'forever,' as Hansen and colleagues put it. In this time, civilizations can rise and fall, and the Greenland and West Antarctic ice sheets could melt substantially, raising sea levels enough to transform the face of the planet.'

²¹ See, for example, House, K.Z., et al., "Economic and energetic analysis of capturing CO₂ from ambient air," *Proceedings of the National Academy of Sciences*, 108(51) (December 2011): 20428-20433, <http://www.pnas.org/content/108/51/20428.full.pdf>. The authors concluded: "Our empirical analysis of energetic and capital costs of existing, mature, gas separation systems indicates that air capture processes will be significantly more expensive than mitigation technologies aimed at decarbonizing the electricity sector. Unless a technological breakthrough that departs from humankind's accumulated experience with dilute gas separation can be shown to "break" the Sherwood plot and the second-law efficiency plot—and the burden of proof for such a process will lie with the inventor—direct air capture is unlikely to be cost competitive with CO₂ capture at power plants and other large point sources."

30. *Second*, Youth Plaintiffs and Affected Children will face increased burdens as taxpayers because, as Defendants and climate scientists project, climate change will increase future losses related to climate variability, sometimes of a catastrophic nature.²² In previous cases of catastrophic loss, society as a whole has borne much of the cost in the form of disaster relief payments from the public sector.²³ Recent examples of catastrophes in which a large proportion of the losses were borne by the public sector include Hurricane Katrina, Hurricane Sandy, Hurricane Harvey, Hurricane Irma, and Hurricane Maria. Each of these disasters has (or will) cost the public sector billions of dollars in disaster relief. For instance, Hurricane Sandy cost the U.S. government over \$50 billion, which is three times larger than the \$18.7 billion of insured losses from that disaster, and over 70

²² “The Impact of Climate Change on Natural Disasters,” NASA, https://earthobservatory.nasa.gov/Features/RisingCost/rising_cost5.php. “Global Warming and Hurricanes,” National Oceanic and Atmospheric Association, <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>. “Climate Change Indicators: Weather and Climate,” EPA, <https://www.epa.gov/climate-indicators/weather-climate>. See also, K. Trenberth et al., “Attribution of climate extreme events,” *Nature Climate Change* 5 (2015): 725-730.

²³ “Potential Increases in Hurricane Damage in the United States: Implications for the Federal Budget”, Congressional Budget Office (CBO), June 2016, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51518-hurricane-damage.pdf>.

Public sector relief is needed in these cases because private risk-pooling solutions, such as property and casualty insurers, do not and cannot cover even a majority of the realized losses. This is true for three primary reasons. *First*, a significant portion of the population is uninsured or underinsured for certain types of losses such as the risk of flood, especially in areas that have not been historically prone to flooding. *Second*, public property may not be insured at all. *Third*, property and casualty insurers are sometimes insufficiently capitalized to cover the enormous losses that such events can potentially cause, and their insolvency forces policyholders to turn to the government for assistance.

This point is illustrated by Hurricane Harvey in 2017, where some estimates of the costs run to nearly \$200 billion, which represents about 1 percent of gross national product. See, e.g., Doyle Rice, “Harvey to be costliest natural disaster in U.S. history, estimated cost of \$190 billion,” *USA Today*, August 31, 2017, <https://www.usatoday.com/story/weather/2017/08/30/harvey-costliest-natural-disaster-u-s-history-estimated-cost-160-billion/615708001/> and Reuters, “Hurricane Harvey Damages Could Cost up to \$180 Billion,” *Fortune*, September 3, 2017, <http://fortune.com/2017/09/03/hurricane-harvey-damages-cost/>. The Treasury Secretary went so far as to speculate that the Federal government’s debt limit would have to be raised to free up spending for disaster recovery, and the Governor of Texas estimated that such relief could require \$180 billion.

Id.

Estimates for Hurricane Maria have been on the order of \$100 billion. See, Jill Disis, “Hurricane Maria could be a \$95 billion storm for Puerto Rico,” *CNN*, September 28, 2017, <http://money.cnn.com/2017/09/28/news/economy/puerto-rico-hurricane-maria-damage-estimate/index.html>.

percent of the total economic damage of the disaster as estimated by the CBO.²⁴ Hurricane Katrina cost the U.S. government over \$110 billion, 75 percent of the total economic damages of the disaster.²⁵ With increased catastrophic losses due to climate change, we can expect that the U.S. government's role as a safety net will expand.²⁶ As this trend continues, taxpayers of the future, including Youth Plaintiffs, will have to make whole the losses of property owners. The continuation, let alone the expansion, of the public sector's role as a safety net will be enormously costly, impose an increased burden and economic disadvantage on Youth Plaintiffs and Affected Children compared to older generations, and result in fewer government resources to be spent on public services.²⁷

31. The National Centers for Environmental Information tracks the impact of weather events on the United States. As they report, from 1980 to 2017 the U.S. has experienced "219 weather and climate disasters since 1980 where overall damages/costs reached or exceeded \$1 billion (including CPI adjustment to 2017). **The total cost of these 219 events exceeds \$1.5 trillion.**"²⁸ (Emphasis in original.) In describing the impact on the U.S. in 2017 (the last full year):²⁹

²⁴ "Catastrophes: U.S.," Insurance Information Institute, <http://www.iii.org/fact-statistic/catastrophes-us>. "Potential Increases in Hurricane Damage in the United States: Implications for the Federal Budget", Congressional Budget Office (CBO), June 2016, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51518-hurricane-damage.pdf>.

²⁵ "Potential Increases in Hurricane Damage in the United States: Implications for the Federal Budget," Congressional Budget Office (CBO), p. 17, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51518-hurricane-damage.pdf>.

²⁶ "Underinsurance of Property Risks: Closing the Gap," Swiss Re, No. 5/2015, http://institute.swissre.com/research/overview/sigma/5_2015.html.

²⁷ The CBO estimates that, by 2075, hurricane losses alone will total 0.22 percent of GDP, or \$39 billion in 2016 dollars, an increase of 40 percent from today's annual levels, and over half of that loss will be borne by the U.S. government. "Potential Increases in Hurricane Damage in the United States: Implications for the Federal Budget," Congressional Budget Office, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51518-hurricane-damage.pdf>.

²⁸ "Billion-Dollar Weather and Climate Disasters: Overview," National Centers for Environmental Information, 2018, <https://www.ncdc.noaa.gov/billions/>.

²⁹ *Id.*

In 2017, there were 16 weather and climate disaster events with losses exceeding \$1 billion each across the United States. These events included 1 drought event, 2 flooding events, 1 freeze event, 8 severe storm events, 3 tropical cyclone events, and 1 wildfire event. Overall, these events resulted in the deaths of 362 people and had significant economic effects on the areas impacted.

32. As the above makes clear, it is not just hurricanes that can cause such costly events. The 2017 wildfire season in California was particularly harsh. Insurance claims at the end of 2017 were approximately \$9.4 billion (with many properties being underinsured or not insured, the total damage is higher),³⁰ and estimates of the total impact on economic activity were \$180 billion (including damages, closures, costs to fight fires, lost sales, etc.).³¹ In 2016, Canada had a similar experience in Fort McMurray, Alberta; insurance payments were the costliest in Canadian history at CAD 3.58 billion,³² and this covered only 70 percent of the total economic loss.³³ Particularly insidious with forest fires is that they also lead to massive injections of CO₂ into the atmosphere. As the Climate Science Special Report (a compilation by the U.S. Global Change Research Program, spanning multiple government agencies) noted about the Alberta wild fires specifically: “They can also radically increase emissions of greenhouse gases, as demonstrated by the amount of carbon dioxide produced by the Fort McMurray fires of May 2016—more than 10% of Canada’s annual emissions.”³⁴ The federal government expends significant financial

³⁰ W. Richter, “We may never be able to know the true cost of California’s massive wildfires,” *Business Insider*, December 7, 2017, <http://www.businessinsider.com/santa-rosa-california-fires-cost-damage-2017-12>.

³¹ “AccuWeather predicts 2017 California wildfire season cost to rise to \$180 billion,” *AccuWeather*, December 8, 2017, <https://www.accuweather.com/en/weather-news/accuweather-predicts-2017-california-wildfire-season-cost-to-rise-to-180-billion/70003495>.

³² “Northern Alberta Wildfire Costliest Insured Natural Disaster in Canadian History – Estimate of insured losses: \$3.58 billion,” Insurance Bureau of Canada, July 7, 2016, <http://www.ibc.ca/ab/resources/media-centre/media-releases/northern-alberta-wildfire-costliest-insured-natural-disaster-in-canadian-history>.

³³ W. Koblensky, “Fort McMurray in top 10 worst insured losses globally,” *Insurance Business Canada*, March 29, 2017, <http://www.insurancebusinessmag.com/ca/news/environmental/fort-mcmurray-in-top-10-worst-insured-losses-globally-63960.aspx>.

³⁴ USGCRP Climate Science Special Report, p. 415.

resources each year on both fire suppression efforts and in the aftermath of wildfires, and while costs do vary from year to year, in general, they are rising.³⁵

33. Other potential examples include agricultural losses. Whether or not insurance reimburses farmers for their crops, there can be food shortages that lead to higher food prices (that will be borne by consumers, that is, Youth Plaintiffs and Affected Children). There is a further risk that as our climate and land use pattern changes, disease vectors may also move (e.g., diseases formerly only in tropical climates move northward).³⁶ This could lead to material increases in public health costs in terms of vaccinations and treatments, at least some portion of which will be borne by future taxpayers, i.e., Youth Plaintiffs and Affected Children. Moreover, the Youth Plaintiffs and Affected Children will be at risk of experiencing directly one or more of these increased health hazards, only a portion of the costs of which will be picked up by insurance or public assistance. There is a risk too that the increased health costs will be reflected in increased insurance premiums, affecting all those relying on private insurance, including some or all of the Youth Plaintiffs and Affected Children.
34. All of these factors will also lead to increasing inequality, as those with financial means are more able to privately bear the costs of these disasters, while those without financial means will not. Those with means will also be able to relocate, perhaps avoiding (for themselves) the burdens of rising sea levels. This will impose a greater burden on those less able to pay for the direct, local consequences of climate change. Such increasing inequality is bad not only for those made worse off, but also for society as a whole, as a more unequal society is one with poorer economic performance.³⁷ This will impose

³⁵ See, e.g., K. Hoover & B. Lindsay, "Wildfire Suppression Spending: Background, Issues, and Legislation in the 115th Congress," Congressional Research Service, October 5, 2017, <https://fas.org/sgp/crs/misc/R44966.pdf>.

³⁶ See, e.g., G. Mercer, "The Link Between Zika and Climate Change," *The Atlantic*, February 24, 2016, <https://www.theatlantic.com/health/archive/2016/02/zika-and-climate-change/470643/>.

³⁷ See, e.g., OECD, "Inequality hurts economic growth, finds OECD research," September 12, 2014, <http://www.oecd.org/newsroom/inequality-hurts-economic-growth.htm> and Prakash Loungani and Jonathan D. Ostry, "The IMF's Work on Inequality: Bridging Research and Reality," IMF, February 22, 2017, <https://blogs.imf.org/2017/02/22/the-imfs-work-on-inequality-bridging-research-and-reality/> ("Another important conclusion of IMF research: rising inequality poses risks to durable

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further costs on the Youth Plaintiffs and Affected Children as they have to adapt to a structurally weaker economy due to increasing inequality (as elaborated on below, inequality is also exacerbated by Defendants' subsidy system that takes from taxpayers and gives to fossil-fuel corporations).

35. **Third**, Youth Plaintiffs will face increased burdens because the more time that passes, the more expensive it becomes to address climate change.³⁸ It is highly likely that, as the consequences and magnitude of climate change become manifest, there will finally be a global consensus for a globally equitable and efficient response.³⁹ At that juncture, the only way to prevent the accumulation of greenhouse gases beyond a tolerable level will be "negative emissions," i.e. taking carbon out of the atmosphere, effectively attempting to undo the damage that is currently being done.⁴⁰ That will be enormously expensive relative to what it would have cost to begin curtailing emissions today.⁴¹ Further, there is no guarantee that Youth Plaintiffs will be able to timely and effectively repair this

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economic growth. This puts addressing inequality squarely within the IMF's mandate to help countries improve economic performance.").

³⁸ See, e.g., "Climate change in the United States: Benefits of Global Action", EPA. Beccherle, Julien and Tirole, Jean, "Regional Initiatives and the Cost of Delaying Binding Climate Change Agreements", *Journal of Public Economics* 95 (December 2011): 1339-1348. Jakob, Michael and Tavoni, Massimo, "Time to act now? Assessing the costs of delaying climate measures and benefits of early action", *Climate Change* 114 (2012): 79-99.

³⁹ See, for example, Climate change in the United States: Benefits of Global Action, EPA, <https://www.epa.gov/sites/production/files/2015-06/documents/cirareport.pdf>.

⁴⁰ See, for example, "The cost of delaying action to stem climate change," Executive Office of the President of the United States, July 2014, p. 13, https://obamawhitehouse.archives.gov/sites/default/files/docs/the_cost_of_delaying_action_to_stem_climate_change.pdf.

⁴¹ Even as these costly actions to undo the damage are undertaken, the effects of failing to act now will likely be felt, in ways described earlier in this report. Each and every one of the Youth Plaintiffs will face a risk of being personally affected, e.g., by increased taxes, increased direct losses, and increased exposure to health risks and to climate variability itself.

A recent estimate pegged the costs of CO₂ extraction to be on the order of \$8 to \$18.5 trillion, or over \$100 billion per year over 80 years, to return to a 350 ppm target by 2100. These costs are much higher with continued high emissions (i.e., if we do not cease fossil fuel use and rely only on carbon capture and storage), being on the order of \$100 trillion or more. See, J. Hansen et al., "Young People's Burden: Requirement of Negative CO₂ Emissions," *Earth System Dynamics*, vol. 8, 2017, pp. 577-616, at 591-592.

damage. In other words, the actions of Defendants in promoting and perpetuating a fossil fuel-based energy system impose a disproportionately higher financial burden and economic disadvantage on Youth Plaintiffs and Affected Children, undermining their economic security and depriving them of the stronger economy that they would have had in the absence of unmitigated climate change.

36. *Fourth*, in the absence of mitigation efforts, there is a significant risk of catastrophic impacts of climate change; indeed, there is overwhelming evidence that such catastrophic impacts are likely to result. Defendants' failure to invest in climate change mitigation and thereby insure against that outcome imposes an enormous degree of risk on Youth Plaintiffs, not experienced by older generations. Events such as the rapid melting of ice sheets and consequent increases in global sea levels or temperature increases on the higher end of the range of scientific forecasts have the potential to entail severe, perhaps even irreparable, consequences.⁴² To confront properly the possibility of climate catastrophes, Defendants must take prudent steps now to reduce the chance of the most severe consequences of climate change. The longer Defendants postpone such action, the greater will be the atmospheric concentration of GHGs and the risk (due to the self-reinforcing and path-dependent⁴³ nature of climate systems and long lags between actions and results, as discussed above). Just as businesses and individuals guard against severe financial risks by purchasing various forms of insurance, Defendants can take actions now that reduce the chances of triggering the most severe climate events. There is no third party from which Defendants could purchase insurance to protect Youth Plaintiffs from the damages that are consequent to Defendants' actions. The only alternative for Defendants is to take actions without delay to reduce the atmospheric concentration of CO₂ in order to restore Earth's energy balance and avert catastrophic and irreversible

⁴² See, Section III, above.

⁴³ By path dependence, I mean that prior actions affect the future trajectory of the economy in ways that are not irreversible, or reversible only at high costs. Accordingly, what is a prudent strategy today depends on decisions made yesterday (and many years ago). Put differently, prior decisions are not something that we can now just walk away from; those prior decisions directly affect the world we live in today and affect the analysis of what is a prudent strategy going forward.

climate change impacts.⁴⁴ Unlike conventional insurance policies, climate and energy policy that serves the purpose of climate insurance also results in cleaner air, improved energy security, and other benefits, many of which are difficult to monetize, like biological diversity or preserving culturally important places, but are nonetheless significant.

37. The benefits of undertaking such actions are disproportionate to the costs, even without taking account of the huge benefits that arise from the reduction of risk itself. This has been documented, for example, in the High-Level Commission on Carbon Prices.⁴⁵ Due to feedback loops, the magnitude of climate change may change much more than the proportionate increase in atmospheric concentrations of GHGs. Likewise, the increases in atmospheric concentrations of GHGs may increase disproportionately relative to emissions,⁴⁶ and the cost of damage wrought by climate change can increase much faster still.⁴⁷ More is being learned about the behavior of the climate system, including the potential timing and likelihood of these worst-case scenarios. However, the paleo-climate record gives scientists at least one good indication of the consequences of different levels of atmospheric CO₂. The last time in the geologic record that CO₂ levels were over 400 ppm, the seas were 70-90 feet higher than sea level today.⁴⁸ The experience of the last

⁴⁴ J. Hansen, “Exhibit A: Declaration of Dr. James E. Hansen in Support of Plaintiffs’ Complaint for Declaratory and Injunctive Relief,” in *Juliana et al. v. United States et al.*, Case No. 6:15-cv-01517-TC, Doc. No. 7-1., 2015, paras. 39, 67, 85.

⁴⁵ The Commission showed that even a modest tax on carbon combined with the elimination of subsidies and certain other regulatory measures and modest public investments would be able to prevent a rise of temperature beyond the 1.5°C to 2°C.

⁴⁶ See, for example, “The study of Earth as an integrated system,” NASA, https://climate.nasa.gov/nasa_science/science/ and National Research Council of the National Academies, “Climate Change: Evidence, Impacts, and Choices,” *The National Academies of Sciences, Engineering, and Medicine*, 2012, http://nas-sites.org/americasclimatechoices/files/2012/06/19014_cvtx_R1.pdf.

⁴⁷ This is discussed in the Stern Review. See, for example, Figure 6.6 showing the exponential increase in reduced GDP per capita as global mean temperature increases. Nicholas Stern, “Stern Review: The Economics of Climate Change”, p. 159, http://unionsforenergydemocracy.org/wp-content/uploads/2015/08/sternreview_report_complete.pdf.

⁴⁸ H. Wanless, “Declaration of Dr. Harold R. Wanless in Support of Answer of Real Parties in Interest to Petition for Writ of Mandamus”, in *United States of America et al. v. United States District Court for the District of Oregon et al.*, Case No. 17-71692, Doc. No. 14-3, para. 52.

quarter century is that there have been many surprises of underestimating adverse climate impacts (e.g., early estimates of sea level rise had not taken into account the effect of the melting of the arctic icecap or the release of methane gases from the tundra).⁴⁹

38. Fair treatment of Youth Plaintiffs by Defendants requires taking due account of some of the worst, but still plausibly possible, cases. In such cases, national income will be lower because of the adverse effects of climate change,⁵⁰ imposing doubly an increased financial burden and economic disadvantage on Youth Plaintiffs and Affected Children: they will face the costs of remediation and adaptation with fewer resources with which to do so. Even if national incomes continue to rise in real terms, the costs of taking remedial climate action are an ever-increasing burden on Youth Plaintiffs and Affected Children as well. Moreover, as discussed in the climate science summary above, we are quickly approaching (or some argue we may have already passed) certain “tipping points” that will dramatically increase costs in a non-linear fashion.⁵¹ Thus, it is not a practical solution to say Youth Plaintiffs and future generations may be more wealthy in the future (in fact, GDP may be lower in the future because of climate effects) and can bear the costs more efficiently than Defendants today (because those costs continue to increase disproportionately and have long-lasting adverse effects). The assumption of ever-increasing national income has significant implications for Defendants’ cost-benefit

⁴⁹ See, for example, Schneider, Stephen H. and Root, Terry L. Ecological implications of climate change will include surprises, *Biodiversity and Conservation* 5 (1996): 1109-1119.

⁵⁰ In one recent study, researchers found that temperature change due to unmitigated global warming will leave global GDP per capita 23 percent lower in 2100 than it would be without any warming. See Burke, M., Hsiang, S. M., & Miguel, E., (2015) “Global non-linear effect of temperature on economic production,” *Nature*, 527 (7577): 235-239.

A per capita 23 percent lowering of GDP is the on-average result, which understates the full potential impact in two ways (much as the on-average temperature increases understate the increase in catastrophic events, as I discussed above). *First*, a 23 percent on-average result includes many states of the world where the average may be much worse. *Second*, a 23 percent on-average result will not affect all persons or all regions equally; those near the bottom of the income distribution that have no savings will suffer from lack of ability to consume, and almost surely these effects will be felt more in coastal regions, from which those near the bottom of the income distribution will lack the financial resources to relocate, further exacerbating their financial difficulties.

⁵¹ See also, “The study of Earth as an integrated system,” NASA, https://climate.nasa.gov/nasa_science/science/.

analysis and development of discount rates and the social cost of carbon, as described in more detail in Section V.C, below.

39. Moreover, it will be necessary to devote a significant proportion of national income to dealing with the consequences of climate change; the standard term is that there will be high costs of adaptation.⁵² Especially disturbing are the impacts on developing countries, many of which are in tropical zones, which will be particularly hard hit. In the U.S., Youth Plaintiffs will not be able to insulate themselves from the global repercussions. The costs of adaptation to climate change by developing countries are well beyond anything that those countries can afford (or will be able to afford in the future). Youth Plaintiffs may recognize that they have a moral responsibility to global citizens elsewhere in the world because of the actions of the U.S., including Defendants, and thus they will bear a burden because of the failure of Defendants to take appropriate actions.⁵³ However, even were they not to do so, the markedly lower incomes in developing countries will set off large migration pressures, which we are already seeing today.⁵⁴

⁵² According to the United Nations Environment (UNEP) report, the cost of adapting to climate change in developing countries could rise to between \$280 and \$500 billion per year by 2050. There will be a significant financing gap unless new and additional finance for adaptation is made available. See UNEP 2016. The Adaptation Finance Gap Report 2016. United Nations Environment Programme (UNEP), Nairobi, Kenya

⁵³ Of course, Defendants do not control global climate emissions. The U.S. is the second-largest current emitter of CO₂ at 15 percent of global emissions (behind only China), and by far the largest historical emitter of CO₂ and GHGs. See, EPA, "Global Greenhouse Gas Emissions Data," *United States Environmental Protection Agency*, data as of 2014, <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data#Country> and J. Gillis and N. Popovich, "The U.S. Is the Biggest Carbon Polluter in History. It Just Walked Away From the Paris Climate Deal," *The New York Times*, June 1, 2017, <https://www.nytimes.com/interactive/2017/06/01/climate/us-biggest-carbon-polluter-in-history-will-it-walk-away-from-the-paris-climate-deal.html>.

However, action by the world's largest historical contributor of GHGs and the world's largest economy (the U.S.) would help further the goals of the Paris agreement and other countries' efforts to reduce GHG emissions. Moreover, it could reduce the incentive for other countries to shirk their climate change efforts by attempting to gain a competitive edge by not addressing climate change (a race to the bottom, so to speak). In any event, however, the fact that other countries, particularly developing countries, may not take as strong an action as is needed is not justification for Defendants using out-dated economic models and analysis to foist high costs on Youth Plaintiffs and Affected Children more generally.

⁵⁴ See, for example, Coral Davenport and Campbell Robertson, "Resettling the First American 'Climate Refugees,'" *The New York Times*, May 3, 2016, <https://www.nytimes.com/2016/05/03/us/resettling->

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Managing this migration (including possibly putting up hard-and costly-to-enforce barriers to it) will impose large costs on Youth Plaintiffs, undermining their economic security.⁵⁵ Moreover, in a globally interconnected system, lower incomes abroad will adversely affect the demand for American goods and services, thereby reducing U.S. GDP from what it otherwise would be, with consequent risks for Youth Plaintiffs and Affected Children.

40. I understand that Defendants argue their policies were necessary for the economic and national security of the U.S.⁵⁶ Such arguments do not withstand economic scrutiny. Whatever benefits might have existed in the middle of the 20th century, it has been decades since such policies were rational. This has been recognized by leading security experts. For example, since at least 2007, members of the U.S. military have recognized that “serious consequences to our national security ... are likely from unmitigated climate

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[the-first-american-climate-refugees.html](#) and Aryn Baker, “How Climate Change is Behind the Surge of Migrants to Europe,” *Time*, September 7, 2015, <http://time.com/4024210/climate-change-migrants/>.

⁵⁵ As discussed in the Stern Review, some estimates suggested up to 200 million people may become permanently displaced by climate change by the middle of this century, noting that almost as many people leave their homes because of environmental disasters as flee political oppression. See, Nicholas Stern, “Stern Review: The Economics of Climate Change”, p. 77, http://unionsforenergydemocracy.org/wp-content/uploads/2015/08/sternreview_report_complete.pdf. See also, K. Burrows & P. Kinney, “Exploring the Climate Change, Migration and Conflict Nexus,” *International Journal of Environmental Research and Public Health* 13(4) (2016): 443, noting that the number of people displaced by climate change by 2050 is estimated to be between 50 million, on the low end, and 1 billion, on the high end.

⁵⁶ See, e.g., “Office of Fossil Energy FY 2019 Budget,” U.S. Department of Energy, <https://www.energy.gov/fe/about-us/our-budget> (“The Office of Fossil Energy (FE) programs are focused on activities related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels that are essential to our Nation’s security and economic prosperity.”).

See also, Jason Furman and Gene Sperling, “Reducing America’s Dependence on Foreign Oil As a Strategy to Increase Economic Growth and Reduce Economic Vulnerability,” Obama White House Archives, August 29, 2013, <https://obamawhitehouse.archives.gov/blog/2013/08/29/reducing-america-s-dependence-foreign-oil-strategy-increase-economic-growth-and-redu> (“...the President’s focus on increasing America’s energy independence is not just a critical national security strategy, it is also part of an economic plan to create jobs, expand growth and cut the trade deficit.” The first element of President’s Obama plan was “Increasing domestic production of oil.”).

change.”⁵⁷ In a report released in 2007, eleven retired military generals and admirals detailed the variety of threats to America’s national and economic security that climate change poses.⁵⁸

In already-weakened states, extreme weather events, drought, flooding, sea level rise, retreating glaciers, and the rapid spread of life-threatening diseases will themselves have likely effects: increased migrations, further weakened and failed states, expanded ungoverned spaces, exacerbated underlying conditions that terrorist groups seek to exploit, and increased internal conflicts. In developed countries, these conditions threaten to disrupt economic trade and introduce new security challenges, such as increased spread of infectious disease and increased immigration. Overall, climate change has the potential to disrupt our way of life and force changes in how we keep ourselves safe and secure by adding a new hostile and stressing factor into the national and international security environment.

41. From an economic perspective, one of the key insights is that, just at the time when money is scarce (and our economy is weak) because of climate change, there will be greater need for funds. Thus, government will be less able to provide the requisite finance for key public services, depriving Youth Plaintiffs and Affected Children of the economic benefits enjoyed by older generations. This makes it even more compelling for Defendants to take all the precautionary measures today that they can.
42. As noted by the High-Level Commission on Carbon Prices (the “High-Level Commission”), which I co-chaired, the estimated economic costs of climate change in many of the standard models, and in particular Defendants’ estimates of the social cost of carbon (under the Obama administration), are:⁵⁹

⁵⁷ “National Security and the Threat of Climate Change,” The CNA Corporation, 2007, p. 44, https://www.cna.org/cna_files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf.

⁵⁸ “National Security and the Threat of Climate Change,” The CNA Corporation, 2007, pp. 44-45, https://www.cna.org/cna_files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf.

⁵⁹ High-Level Commission on Carbon Prices, “Report of the High-Level Commission on Carbon Prices”, 2017, Washington, DC: World Bank, Appendix A.

...biased downward because they fail to consider many vitally important risks and costs associated with climate change—particularly the widespread biodiversity losses, long-term impacts on labor productivity and economic growth, impacts on the poorest and most vulnerable, rising political instability and the spread of violent conflicts, ocean acidification, large migration movements, as well as the possibility of extreme and irreversible changes.

43. Thus, it is prudent for Defendants to take precautionary actions, not based on the “average” estimate of what the damage might be, but rather based on estimates of realistically plausibly possible “worst cases.” Because, as detailed below, Defendants could take actions at modest costs, and it would be reckless not to undertake those actions; it would be needlessly endangering the future prospects and the economic and personal security of Youth Plaintiffs and Affected Children.

V. TRANSITIONING THE U.S. ECONOMY OFF OF FOSSIL FUELS IS NOT ONLY FEASIBLE BUT WILL BENEFIT THE ECONOMY

A. TRANSITIONING OFF OF FOSSIL FUELS IS FEASIBLE

44. There is broad consensus among economists, and the High-Level Commission concluded, that limiting temperature increase to “well below 2°C” is achievable with reasonable and modest measures, and that the costs of those measures are far smaller than the costs of the damage that climate change could inflict.⁶⁰
45. The High-Level Commission estimated that the costs of curtailing emissions to a level to achieve the goals set forth by the Paris Agreement (“well below 2°C”) would be modest.⁶¹ The High-Level Commission noted that the carbon tax, that they explained could induce the requisite change in emissions, could substitute for other more distortionary taxes. If governments made such a substitution, the aggregate cost of curtailing carbon emissions could even be less than zero, providing net benefits to the economy. Furthermore, at a time when so much discussion focuses on the Federal government’s deficit spending (and our national debt), the elimination of billions of dollars of often-hidden subsidies to the fossil fuel industry would improve the country’s fiscal situation and economic performance generally. As discussed below in Section V.B, the full amount of post-tax subsidies in the U.S. has been estimated at nearly \$700 billion a year, more than half of the Federal government’s forecasted deficit for the next fiscal year.⁶² Eliminating all fossil fuel subsidies (implicit and explicit, many of which

⁶⁰ High-Level Commission on Carbon Prices, “Report of the High-Level Commission on Carbon Prices”, 2017, Washington, DC: World Bank, p. 1.

⁶¹ When I use the term “costs” here, I refer to the net effect of undertaking such policy changes—that is, such costs can be negative (when the benefits outweigh the costs). As is standard in economic analysis, I analyze the *marginal* effects, that is, the marginal (i.e., additional as compared to the *status quo*) net outlays that will be required for effectuating a given policy choice. Because certain policy choices can have long-term benefits that outweigh long-term costs, negative costs are a distinct possibility.

⁶² Coady et al., “How Large Are Global Energy Subsidies?”, IMF Working Paper, Fiscal Affairs Department, 2015, paper and underlying data available at: <https://www.imf.org/en/News/Articles/2015/09/28/04/53/sonew070215a>.

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go to large corporations) could, therefore, both curtail fossil-fuel production, through forcing companies to bear more of the true costs of fossil-fuel production, and substantially reduce our national deficit in one fell swoop. Equity would also be improved with corporations paying more and individuals, such as the Youth Plaintiffs and Affected Children, benefiting.

46. There are many reasons to be optimistic that emissions could be curtailed further than previously thought. These benefits are a result of continued technological development in the renewables sector. Because of technological improvements, the costs of renewables and storage are decreasing. The price of solar panels has dropped by more than half in recent years (80 percent reduction from 2008 to 2016).⁶³ In 2016 alone, the average dollar capital expenditure per megawatt for solar photovoltaics and wind dropped by over 10 percent.⁶⁴ As these technologies continue to improve and the efficiency increases, while manufacturing costs drop, these technologies will more easily substitute for existing fossil fuel infrastructure.
47. Transitioning to a non-fossil-fuel-based economy will require additional investment in our energy sector. Such sectoral shifts in our economy are not uncommon. In fact, a hallmark of a well-functioning market economy is its ability to shift between sectors as

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See also a report published by the Overseas Development Institute and Oil Change International, which found that as of 2014, the U.S. government provides approximately \$20 billion annually in producer side subsidies through various tax exceptions/deductions.

Doukas, Alex, "G20 subsidies to oil, gas and coal production: United States", Overseas Development Institute, 2015, <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9979.pdf>.

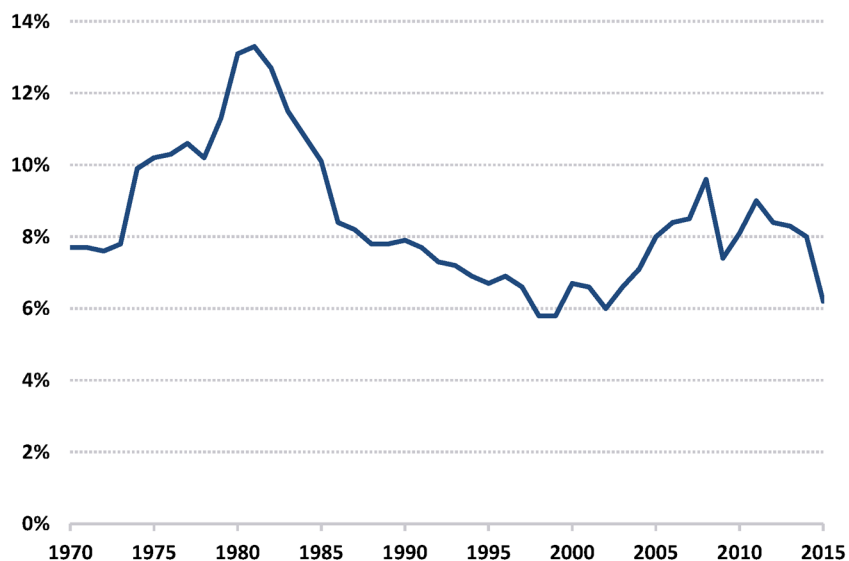
With the recent tax cuts, the deficit is currently forecasted to be about \$1 trillion in the next fiscal year. See, Associated Press in Washington, "US deficit to approach \$1tn after Trump tax cuts and spending bill, CBO says," *The Guardian*, April 9, 2018, <https://www.theguardian.com/us-news/2018/apr/09/us-deficit-trump-tax-cuts-trillion-cbo-projection>.

⁶³ See, e.g., Ryan Whitman, "We could be headed for a solar power renaissance as costs keep dropping," *ExtremeTech*, December 19, 2016, <https://www.extremetech.com/extreme/241300-headed-solar-power-renaissance-costs-keep-dropping>.

⁶⁴ Frankfurt School-UNEP Centre/BNEF, "Global Trends in Renewable Energy Investment 2017," 2017, <http://fs-unep-centre.org/sites/default/files/publications/globaltrendsrenewableenergyinvestment2017.pdf>.

technology changes and demand fluctuates. For example, we have seen shifts from agriculture to manufacturing to services over the course of the twentieth century, and we saw a shift towards the financial sector (from less than 3 percent to over 8 percent of GDP) from the 1950s to its peak in 2006 (immediately before the financial crisis).⁶⁵ Our spending on our energy sector has also fluctuated, as the chart below shows energy expenditures as a percent of GDP from 1970 to 2015. While the high levels of spending in the early 1980s (over 10 percent) were during periods of economic turbulence with high inflation and an energy crisis, there have been other periods, such as the 2000s and the early 1970s where there was economic growth and high spending on our energy system. Moreover, our economy has endured sudden, unplanned disruptions in the past (again, for example, the financial crisis); moving our economy to one without fossil fuels would come with a slight cost, but would be an event we can plan for to minimize disruptions (and would bring net benefits in the form of risk reduction).

⁶⁵ See, e.g., Robin Greenwood and David Scharfstein, “The Growth of Finance,” *Journal of Economic Perspectives*, 27(2) (Spring 2013): 3-28.

Figure 1: Energy Expenditures as Share of GDP (Percent)

Source: U.S. Energy Information Administration, March 2018 Monthly Energy Review, Table 1.7 Primary Energy Consumption, Energy Expenditures, and Carbon Dioxide Emissions Indicators.

48. There are a number of important new “energy smart” technologies that can play a role in reducing dependence on energy, making our existing energy infrastructure more efficient.⁶⁶ Smart grids, for example, can turn on appliances when renewable electricity is plentiful—and ramp down electric loads when renewable power wanes. Advanced energy storage technologies are increasingly diverse and many, like ice energy storage, are simpler and can be more cost effective than chemical batteries. Electric vehicles can also be considered “energy smart” technology, as their charging and discharging of batteries can be flexible, creating great potential to improve the efficiency of our national energy infrastructure. These technologies reduce overall energy consumption, so that even without the introduction of less carbon intensive energy sources, they can reduce

⁶⁶ Frankfurt School, UNEP Centre, “Global Trends In Renewable Energy Investment 2017,” <http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf>.

carbon emissions. Many energy efficiency technologies actually have a negative cost to implement, especially if one includes in the costs the implicit costs associated with GHG emissions (costs to society that are currently externalized).⁶⁷

49. The major U.S. corporations that have committed themselves to dramatic emissions reductions—as well as state and local governments that have committed to emissions reductions—support the feasibility of a swift transition.⁶⁸ Creating predictability is of significant economic value in aggressively seeking to reduce emissions; i.e., it makes clear to players in the future economy that they can plan accordingly with very high confidence. In addition, this greater certainty facilitates the production of goods and services at lower costs. For instance, the Chief Executive Officers of Apple, BHP Billiton, BP, DuPont, General Mills, Google, Intel, Microsoft, National Grid, Novartis Corporation, Rio Tinto, Schneider Electric, Shell, Unilever, and Walmart all called on the President to stay the course with respect to United States’ participation in the Paris Agreement.⁶⁹ So too, were the Defendants to adopt a high and reliable price of carbon, households and firms would know that it paid economically to adopt low- or zero-emission technologies and products.
50. In pursuing clean-energy technology, there is also the potential for increasing overall economic production and stimulating aggregate demand and economic growth. As I

⁶⁷ See, e.g., European Commission, “The Macroeconomic and Other Benefits of Energy Efficiency”, https://ec.europa.eu/energy/sites/ener/files/documents/final_report_v4_final.pdf.

⁶⁸ In 2017, for example, nine states making up the Regional Greenhouse Gas Initiative consortium agreed to a cap-and-trade program that seeks a 30 percent reduction in carbon pollution from energy plants by 2030. See, Colin Young, “9 states, including Mass., Agree to Accelerate Emission Reductions in Next Decade,” *WBUR*, August 23, 2017, <http://www.wbur.org/news/2017/08/23/9-states-including-mass-agree-to-extend-carbon-reduction-goals-to-2030>.

Other state-driven strategies include California’s January 2018 announcement to have 5 million zero-emission vehicles in use by 2030; Hawaii mandating that all of the state’s electricity come from renewable sources by the mid-21st century; and Vermont’s commitment to reduce emissions to 80-95 percent below 1990 levels by 2050. See, “U.S. Leads in Greenhouse Gas Reductions, but Some States are Falling Behind,” Environmental and Energy Study Institute, March 27, 2018, <http://www.eesi.org/articles/view/u.s.-leads-in-greenhouse-gas-reductions-but-some-states-are-falling-behind>.

⁶⁹ See, e.g., Center for Climate and Energy Solutions, “Top companies urge White House to stay in the Paris Agreement,” Center for Climate and Energy Solutions Press Release, April 2017, <https://www.c2es.org/newsroom/releases/major-companies-urge-white-house-stay-paris>.

wrote a few years ago in *The Guardian*, “retrofitting the global economy for climate change would help to restore aggregate demand and growth.”⁷⁰ Consistent with this, the High-Level Commission, which I co-chaired with Lord Stern,⁷¹ found that “climate policies, if well designed and implemented, are consistent with growth, development, and poverty reduction. The transition to a low-carbon economy is potentially a powerful, attractive, and sustainable growth story, marked by higher resilience, more innovation, more livable cities, robust agriculture, and stronger ecosystems.”⁷²

51. However, instead of supporting existing clean energy technology that would benefit the economy and create jobs, Defendants are acting in ways to suppress and hinder clean energy, which also leads to job losses and harms the economy. For example, in January 2018, President Trump approved tariffs on imported solar cells that start at 30 percent. The tariffs are unlikely to benefit American solar manufacturing jobs, but, according to the Solar Energy Industries Association, are likely to result in the loss of 23,000 American jobs this year and the delay or cancelation of billions in solar investments. The tariffs are also expected to lead to a net reduction in solar installations by roughly 11 percent between 2018 and 2022, a 7.6-gigawatt reduction in solar PV capacity, which means approximately 1.2 million homes will not be powered by renewable solar energy. Such tariffs are both harmful for the environment and the economy.⁷³
52. Not promptly undertaking actions to pursue clean-energy technology continues to expose Youth Plaintiffs and Affected Children to the risk of extreme costs and damages, not just from climate change itself, but from the required outlays on future remediation and adaptation efforts and a weaker, less efficient, and more expensive U.S. economy.

⁷⁰ Stiglitz, J., “Climate Change and Poverty Have Not Gone Away,” *The Guardian*, January 7, 2013, <https://www.theguardian.com/business/2013/jan/07/climate-change-poverty-inequality>

⁷¹ Lord Stern succeeded me as Chief Economist of the World Bank and subsequently was a leading economic advisor to the UK Treasury, as Second Permanent Secretary and head of the Government Economic Service.

⁷² High-Level Commission on Carbon Prices, “Report of the High-Level Commission on Carbon Prices,” 2017, Washington, DC: World Bank, p. 1.

⁷³ Julia Pyper, “New Tariffs to Curb US Solar Installations by 11% Through 2022,” *Greentech Media*, January 23, 2018, <https://www.greentechmedia.com/articles/read/tariffs-to-curb-solar-installations-by-11-through-2022#gs.YNvdYQ>

B. POLLUTION IS A CLASSIC EXTERNALITY THAT CAN BE COMBATED WITH STANDARD ECONOMIC TOOLS THAT PROMOTE SOCIAL WELFARE

53. Currently, around 80 percent of the energy consumed in the U.S. comes from fossil fuels.⁷⁴ In contrast, renewable energy sources comprise 11 percent of total energy consumption. That percentage has only risen by 2 percent (9 to 11 percent) from 1949 to 2017.⁷⁵
54. The burning of fossil fuels generates large amounts of pollution. Pollution is the archetypal negative externality. In economics, an externality arises when the cost or benefit of an activity of one party imposes a cost or benefit on another. In the pollution example, the polluter makes a good (its primary activity), but in the course of doing so generates pollution that imposes a cost or burden on another (e.g., a fisherman who fishes in the waters that become polluted will catch fewer fish). A positive externality example might be a technological development that benefits more than the inventor alone (e.g., the developer of the worldwide web who made it freely available).
55. The issue that arises with a negative externality is that the producer of the externality (e.g., the polluter) considers only their private costs when making production decisions and not the total costs of their activity (the costs borne by the polluter and the fisherman). Standard economic theory argues that private markets can be relied on to make efficient decisions, if, and only if, the (marginal private) costs confronting individuals equal the (marginal) social costs, and the (marginal private) benefits confronting them equal the (marginal) social benefits. When there is an externality, social and private costs and/or benefits are not aligned. A classic way to intervene in this situation is for government to tax the causes of negative externalities (thereby raising the effective private cost closer to

⁷⁴ U.S. Energy Information Administration, Table 1.3 Primary Energy Consumption by Source, March 2018 Monthly Energy Review, <https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T01.03&freq=m>.

⁷⁵ U.S. Energy Information Administration, Table 1.3 Primary Energy Consumption by Source, March 2018 Monthly Energy Review, <https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T01.03&freq=m>.

the social cost and forcing the producer to bear the full cost of their actions).⁷⁶ Having a well-functioning price system—where price setters take into account all costs—is important for economic efficiency and overall social welfare.

56. At present, the U.S. lacks a comprehensive carbon-pricing regime that accounts for the negative externalities of burning fossil fuels such that private markets can be relied on to make efficient decisions. Thus, producers and sellers of fossil fuels consider only their private costs and benefits, and the costs that their activities are imposing on society through, among other factors, increased GHG emissions and long-term climate effects of the sort I discussed earlier are not considered or internalized as part of the price.
57. Beyond the lack of a comprehensive carbon-pricing regime, a faulty system that is full of hidden subsidies for fossil fuels, as noted above, hinders the transition towards a less carbon-intensive economy. These subsidies also accelerate and exacerbate the costs to Youth Plaintiffs from climate change.
58. These subsidies take many forms. For instance, upstream oil and gas exploration and production companies in the U.S. receive several tax breaks that go beyond those afforded to businesses generally, such as deducting intangible drilling costs as a current business expense (not capitalized over the life of the well), depletion allowances,⁷⁷ and offshore drilling tax royalty relief (which permits the claiming of foreign royalties as taxes (and makes them creditable against U.S. taxes) for taxpayers taxed in two countries). When companies make an investment, it is natural that they be allowed to depreciate the cost of the capital as a tax-deductible expense over the lifetime of the asset.

⁷⁶ Sometimes, governments have to rely on “second best” interventions. Thus, government can subsidize alternatives (or positive-externality activities), which lowers the effective price of substitute products. Lowering the price of a substitute product can have the effect of increasing demand for the substitute (e.g., clean energy) and reducing the demand for the original product (e.g., fossil fuel-based energy). But leaving the negative externality-generating activity without a “charge” for its external effects leaves a distortion in place.

⁷⁷ I have studied the economics of depletion allowances, together with Sir Partha Dasgupta, in my academic work. See, J.E. Stiglitz, “Monopoly and the Rate of Extraction of Exhaustible Resources,” *The American Economic Review* 66(4) (September 1976): 655-661 and P. Dasgupta and J.E. Stiglitz, “Uncertainty and the Rate of Extraction Under Alternative Arrangements,” *Institute Mathematical Studies in the Social Sciences*, tech. rep. no. 179 (September 1975).

But with depletion allowances, an oil company can deduct 15 percent of the revenue as a “depletion allowance,” regardless of the amount of investment it made to find the oil.⁷⁸ The company receives the depletion allowance—as if it invested money—even if it makes no investment. The value of this provision itself is enormous; some estimates say it could save the U.S. Treasury over \$11 billion in 10 years if it were eliminated.⁷⁹ (Money not received by Treasury is, in effect, money given to the fossil fuel industry.) Coal companies can receive similar corporate tax reductions, and are able to purchase or lease land from Defendants at below market rates.⁸⁰ These tax breaks artificially reduce the private cost of fossil fuels to producers and consumers (but not the social cost), which makes renewable sources of energy appear less competitive to consumers.⁸¹ In the U.S., these tax breaks for fossil fuel companies have resulted in an economy heavily dependent on fossil fuels and infrastructure designed around fossil fuels.

59. Similarly, at various times, oil, gas, and coal leases have been conducted in ways in which fossil fuel companies are able to obtain leases at prices far below what the competitive equilibrium price would be, depriving taxpayers of money they need for a variety of public purposes, while distorting the market to make participation in oil, gas, and coal more economically attractive.⁸² The efficient auctions that have been used in

⁷⁸ This provision dates to 1913. See, e.g., Rebecca Leber, “Happy 100th Birthday, Big Oil Tax Breaks,” *Think Progress*, March 1, 2013, <https://thinkprogress.org/happy-100th-birthday-big-oil-tax-breaks-3c9731c4bc85/>. See also, Seth Hanlon, “Big Oil’s Misbegotten Tax Gusher,” *Center for American Progress*, May 5, 2011, <https://www.americanprogress.org/issues/economy/news/2011/05/05/9663/big-oils-misbegotten-tax-gusher/>.

⁷⁹ See, Seth Hanlon, “Big Oil’s Misbegotten Tax Gusher,” *Center for American Progress*, May 5, 2011, <https://www.americanprogress.org/issues/economy/news/2011/05/05/9663/big-oils-misbegotten-tax-gusher/>.

⁸⁰ Doukas, Alex, “G20 subsidies to oil, gas and coal production: United States”, Overseas Development Institute, 2015, <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9979.pdf>.

⁸¹ Bridle, Richard, Kitson, Lucy, “The Impact of Fossil-Fuel Subsidies on Renewable Electricity Generation”, International Institute for Sustainable Development, December 2014, <http://www.iisd.org/sites/default/files/publications/impact-fossil-fuel-subsidies-renewable-electricity-generation.pdf>.

⁸² This was the case, for instance, in the early 1980s, when large numbers of tracts were simultaneously put up for auctions, so many that the average tract had less than two bidders. I discussed some of the

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other areas (e.g., for the auctioning of the electro-magnetic spectrum) were typically never used. A 2016 report from the President's Council of Economic Advisors regarding coal leases recognized several of these points explicitly, noting, for example, that the coal leasing program "has been widely criticized in recent years by economic and environmental experts for providing a poor return to the taxpayer and for not adequately addressing the environmental costs of coal extraction, processing, and combustion."⁸³ The report also found that previous and then-current policies of Defendants had misaligned incentives: "the program has been structured in a way that misaligns incentives going back decades, resulting in a distorted coal market with an artificially low price for most Federal coal and unnecessarily low government revenue from the leasing program."⁸⁴ The report suggests that to fully reflect the social costs of coal extraction—i.e., price the externality completely—the costs are so high that the resulting royalty rate may be "well-over 100 percent."⁸⁵

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research in this instance in my Nobel lecture. See, J.E. Stiglitz, "Information and the Change in the Paradigm in Economics," Prize Lecture, December 8, 2001, pp. 489-490, https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2001/stiglitz-lecture.pdf.

See also, J.J. Leitzinger and J.E. Stiglitz, "Information Externalities in Oil and Gas Leasing," *Contemporary Policy Issues* 5 (March 1984): 44-57 and J.E. Stiglitz, "What is the Role of the State?" Chapter 2 in M. Humphreys, J.D. Sachs, and J.E. Stiglitz (eds.) "Escaping the Resource Curse," 2007, Columbia University Press, pp. 23-52 at p. 31: "When competition for the resources is limited—and especially when it is known that it is limited—then the prices that prevail will be lower. There are three ways of limiting competition. The first is suddenly to put up for lease a large number of tracts— increase the supply so that the bidding on each tract is limited. This is what President Reagan did in the early 1980s. It was like a fire sale—as if the government had to get rid of its holdings immediately. But in fact, there was no reason for it; it was not as if the oil was going to disappear, or as if the United States needed to raise cash quickly. On a very large fraction of tracts, there was only one bidder (and, of course, the oil companies knew this). In a study I conducted with Jeff Leitzinger (1984) we quantified the impact on the price the government received. The government got a fraction of what it would have earned had the tracts been put up in a more orderly process, and the extra profits went into the coffers of the oil companies."

⁸³ "The Economics of Coal Leasing on Federal Lands: Ensuring a Fair Return to Taxpayers," Executive Office of the President of the United States, June 2016, at p. 2, https://obamawhitehouse.archives.gov/sites/default/files/page/files/20160622_cea_coal_leasing.pdf.

⁸⁴ *Id.*

⁸⁵ *Id.* at p. 29.

60. An important source of protection against global warming is carbon-sequestration—holding carbon in trees, plants, wetlands, or soils. Carbon molecules that are thus held are carbon molecules that are not in the atmosphere.⁸⁶ There are large amounts of public land holding millions of acres of trees, but the government has an industry-driven policy framework in which (a) the timber industry, which acquires the right to cut down the timber, does not pay for the carbon costs of their activities; (b) the timber industry is typically subsidized through roads constructed by the Department of Agriculture, which manages these public forests; (c) the timber industry, like the fossil fuel industry, receives favorable tax benefits; and (d) the timber industry acquires these assets at prices that are below prices that would prevail in a competitive market that accounted for all private and public costs of logging.⁸⁷
61. The provision of these tax benefits and the sale and/or lease of these public assets at below competitive market prices by Defendants harms the U.S. today, and these Youth Plaintiffs and Affected Children, in multiple ways. The harm to the U.S. arises because improper pricing that ignores the externalities of logging leads to inefficient uses of forests, logs, and wood products that would not materialize if the price of logs reflected the carbon costs of cutting down the trees and releasing CO₂ into the atmosphere. These actions by Defendants support the destruction of forests, which are needed to sequester CO₂ (not to mention all the critical ecosystem benefits forests provide). The poorly functioning price mechanism deprives our society of governmental revenues that could be used for multiple purposes, including investment in emission reductions and investments in R&D that would facilitate the transition towards a green economy; and forces taxes to be imposed elsewhere, with distortionary costs—so that total costs to society are well in excess of the losses of tax revenues. The resulting weaker economy

⁸⁶ For a more thorough articulation of this framework, see J.E. Stiglitz, “Sharing the Burden of Saving the Planet: Global Social Justice for Sustainable Development: Lessons from the Theory of Public Finance,” Columbia University Academic Commons, <https://doi.org/10.7916/D8KD24MX> and Mary Kaldor and Joseph E. Stiglitz, eds., *The Quest for Security: Protection without Protectionism and the Challenge of Global Governance*, New York: Columbia University Press, pp. 161-190.

⁸⁷ See, e.g., “Congressional Subsidies for Private Logging,” Taxpayers for Common Sense, December 13, 2001, <http://www.taxpayer.net/library/article/congressional-subsidies-for-private-logging>.

means that Youth Plaintiffs are inheriting an economy that is not only dirtier than it otherwise would have been, but also weaker.

62. There are also indirect explicit subsidies that contribute to the continued reliance on fossil fuels, such as government investments and policies that promote emission producing methods of transportation or manufacturing.
63. Another implicit subsidy granted by governments is to not charge the fossil fuel industry for the negative externalities they create, such as carbon emissions. As discussed above, carbon emissions, and pollution in general, are negative externalities that can affect society and the economy, yet the vast majority of negative-externality carbon emissions across the globe are not priced.⁸⁸ Pricing CO₂ emissions and emissions of other GHGs would greatly enhance revenues available to government to address a variety of societal needs, as I discussed in Section IV above. A basic principle of taxation is that it is better to tax bad things like pollution than good things like savings and work. Again, the resulting weaker economy means that Youth Plaintiffs are inheriting an economy that is not only dirtier than it otherwise would have been, but also weaker. In this instance, not only are Defendants not raising revenue in an efficient way (subsidizing rather than taxing carbon emissions), Youth Plaintiffs are burdened with the socioeconomic costs that arise with pollution, such as additional healthcare costs.
64. Defendants have recognized for at least 40 years that these direct and indirect subsidies to fossil fuel producers hinder the adoption of renewable energy and improvements in

⁸⁸ See, e.g., High-Level Commission on Carbon Prices, "Report of the High-Level Commission on Carbon Prices," 2017, Washington, DC: World Bank, at p. 35: "The carbon prices observed span from less than US\$1/tCO₂e to US\$126/tCO₂e, 85 percent of global emissions are not priced today..."

Because all emissions generate externalities, for an efficient economy, all emissions should be taxed. In a few instances, the adverse effects of not taxing the emissions can be mitigated by the imposition of regulations.

renewable energy technologies. For example, a 1978 memo to President Carter regarding solar power found that:⁸⁹

Widespread use of solar energy is also hindered by Federal and state policies and market imperfections that effectively subsidize competing energy sources. These policies include Federal price controls on oil and gas, a wide variety of direct and indirect subsidies, and utility rate structures that are based on average, rather than marginal costs. Also, the market system fails to reflect the full social benefits and costs of competing energy sources, such as the costs of air and water pollution.

65. If Defendants stopped providing subsidies and/or implemented carbon pricing policies that allow the U.S. government to further fund research and development of green technologies to decarbonize the economy, such measures would have a large positive impact in the long term. These positive effects are not limited to mitigating the environmental effects; there are monetary gains, too. Some estimates of the financial benefit to the U.S. economy of accelerating technological developments for lowering carbon emissions suggest that they would amount to \$1 trillion by 2050.⁹⁰
66. This monetary estimate does not take into account possible spillover effects from advancing technology that could provide further value to the economy (e.g., in the same way that the space race or developments in the world wars brought us many advancements in basic science that made their way into consumer and industrial products). Even without technological change, the net financial costs to the economy may be negative, taking into account the financial benefits of eliminating carbon subsidies and replacing them with carbon taxes and the consequent development of a more efficient low-carbon energy system.
67. A short-term measure Defendants can readily implement is to cease approvals for any new fossil fuel infrastructure, pending completion of a national climate recovery plan. Any new coal projects or coal extraction harms Youth Plaintiffs. For example, it

⁸⁹ Attachment to Memorandum from Jim Schlesinger to The President, “Domestic Policy Review of Solar Energy: A Response Memorandum to The President of the United States,” December 5, 1978, at p. iv.

⁹⁰ Richard G. Richels, Geoffrey J. Blanford, “The value of technological advance in decarbonizing the U.S. economy,” *Energy Economics* 30(6) (2008): 2930-2946, ISSN 0140-988.3.

increases GHG emissions locking in higher concentrations of GHGs in the atmosphere as Youth Plaintiffs grow up and live their lives, with all the attendant costs and impacts that I have described thus far. Enabling investments in long-lasting “fossil” infrastructure (like coal-burning power plants and oil and natural gas pipelines) means that for decades going forward, there will continue to be incentives to engage in costly carbon emissions. Once the plants are built, the owners have an incentive to continue using it to recover their investment (and in so doing, generate GHG emissions). Furthermore, should a fossil-fuel plant be shut down before the natural end of its economic life, there will be allegations of lost economic value (the owners’ private loss on their investment). Such allegations will become a political argument against taking further actions curbing emissions. (These arguments will almost surely be put forward even though the public benefits of shutting down the coal fired plants may be enormous—as I have noted—and even though a standard argument in economics is that by-gones-are-by-gones. Mistaken investments in the past should not continue to justify distorted power generation. Elsewhere, however, the “politics” of stranded assets has played an important role—that is to say; private owners of large, sunk investments have (successfully) argued for preferential treatment for them to recoup their private investments, despite the attendant social costs.)

68. I should also respond to an expected argument from Defendants that, even if the U.S. were to lower its GHG emissions, other countries would increase their production of goods that create GHGs. This might be referred to as a “substitution” argument. There are two rejoinders to this:
 - a. First, I turn to standard economic theory. That is, that in any given equilibrium the lowest-cost providers are providing any given resources. Thus, if the U.S. is providing GHG-dependent products today, it is because the marginal cost of the U.S. providing such products is below the next-cheapest alternative. If the U.S. were to cease producing, say, 100 “units” of GHGs, the next-cheapest alternative would increase its production by less than 100 “units” (because if it made economic sense for the next-cheapest alternative to produce more than 100 “units” they would already be doing so). As such, any substitution will be less than perfect and reductions in

U.S. emissions will be offset less than one-to-one by alternative supplies (i.e., there will be a net reduction).

- b. Second, specific to GHG emissions, recent technical studies have shown that U.S. emissions will not be perfectly offset.⁹¹ This is consistent with the general theory I mentioned above. While climate change is a global problem, the U.S. is a significant contributor to GHG emissions, and so actions by the U.S., both directly, and by the leadership which such actions provide, has a significant impact on these global outcomes. Indeed, the U.S. stands out as the sole country announcing that it is not committed to the reduction of carbon emissions, having announced that it will leave the Paris Agreement. Despite the U.S.'s actions, other countries remain committed. Thus, if the U.S. were to recommit itself to climate action, there is no significant risk of other countries polluting more, so as to offset the benefits of U.S. reductions in carbon emissions.

- 69. The government has recognized since the 1980s that the U.S. will need to take a leadership role in climate change. For example, a government memorandum from 1989 discusses the desire for the U.S. to have a leadership role in addressing climate change. The memorandum also makes clear that when it comes to addressing climate change the U.S. "simply cannot wait -- the costs of inaction will be too high."⁹²

C. DEFENDANTS' USE OF DISCOUNTING IN DECISION-MAKING UNDERESTIMATES THE COSTS OF CLIMATE CHANGE ON YOUTH PLAINTIFFS AND FUTURE GENERATIONS AND THE BENEFITS OF MITIGATION, WITH DELETERIOUS CONSEQUENCES

- 70. In running the government, Defendants must repeatedly make decisions about projects and policies. They must evaluate alternative choices with which they are confronted. In this section, I explain that the way Defendants do this systematically undermines the

⁹¹ See, e.g., P. Erickson and M. Lazarus, "Would constraining US fossil fuel production affect global CO2 emissions? A case study of US leasing policy," *Climatic Change*, 2018, <https://doi.org/10.1007/s10584-018-2152-z>.

⁹² Memorandum from Frederick M. Bernthal to Richard T. McCormack, Department of State, February 9, 1989, attachment "Environment, Health and Natural Resources Issues," and responses to "Question #1."

interests of Youth Plaintiffs in a way which cannot be justified. Indeed, economic science provides sound alternative methodologies for the evaluation of policies and projects which systemically lead to better outcomes for society in general, and would not systematically discriminate against Youth Plaintiffs in the way that existing policies do.

71. While there are a number of longstanding and well-established perspectives in economics which recognize that delaying the kinds of precautionary actions suggested above is deleterious to societal welfare, government practices and procedures underlying important decision-making systematically undervalue the costs to be borne by future generations (including Youth Plaintiffs and Affected Children).
72. The issue devolves around how governments should value benefits and costs that arise at some future date relative to those that occur today. Typically, less value is given to future effects than to current effects. The question is, how much less. Since the most catastrophic effects of climate change may not be felt for years (see paragraph 27 and footnote 19, above), saying that what happens in the future does not matter much biases public decision making against taking actions to protect Youth Plaintiffs.
73. The standard methodology for making such assessments is called cost-benefit analysis. In a cost-benefit analysis, using a discount rate is commonplace; however, that discount rate must be appropriate. As I have noted, issues around discounting are especially important in the context of climate change because the full benefits may not accrue for many years after society incurs costs to limit the emissions of GHGs.⁹³
74. Formal intertemporal analysis on which so much of modern economics is based originated with the path breaking work of Frank Ramsey, who argued that there was no ethically defensible justification for discounting the well-being (utility) of future

⁹³ There is also a problem with how discounting is often applied when we consider future costs compared to future benefits. Standard economic theory says that risky future benefits (e.g., uncertainty regarding an investment's return) are discounted to account for that risk. That is, risky benefits are worth less than riskless benefits. When we consider costs, however, analysts often *reduce* risky costs: uncertainty regarding future costs should decrease the value of a project (i.e., increase its costs), not increase the value of a project.

generations.⁹⁴ In the almost one century since his work, no one has developed a persuasive argument to the contrary.⁹⁵

75. There is an argument that future consumption should be discounted, since future incomes are assumed to be higher, and standard arguments of diminishing marginal utility imply that if that is the case, the value of consumption will be lower. But the high discount rates used by Defendants can only be justified by the assumption of high future increases in standards of living. Since 2008, there is overwhelming evidence that the pace of productivity has declined markedly, implying that we cannot count on past rates of increases prevailing in the future. There is one school of thought (studied and advocated by Prof. Robert Gordon at Northwestern) that argues even the current pace of

⁹⁴ Clearly, if one thought that the world would end, say in 50 years, as a consequence of a nuclear war, unrelated to climate change, one would not need to take into account events beyond the 50-year extension. We rule out such possibilities, or assume that they are of sufficiently low probability as not to affect our analysis.

For mathematical tractability, many analyses assume a small, positive pure intergenerational discount rate. While ethically indefensible for our purposes, the results are not much different from those obtained with a zero discount rate.

⁹⁵ In the middle of the twentieth century, two teams of researchers, each with a prominent Nobel Prize winner, formulated “guides” to cost benefit analysis. See Dasgupta, Sen, and Marglin, prepared for UNIDO (the United Nations Industrial Development Organization) (P. Dasgupta, S.A. Marglin, A. Sen, *Guidelines for project evaluation*, United Nations Industrial Development Organization, Vienna (1972) (United Nations publication sales no.: E.72.II.B.11)) and Little and Mirrlees, prepared for OECD Development Center (I.M.D. Little and J.A. Mirrlees, *Manual of Industrial Project Analysis in Developing Countries vols. 1 and 2*, OECD, Paris (1968, 1969). Amartya Sen received the Nobel prize in 1998, Partha Dasgupta was knighted in 2002, Ian Little was the Deputy Director of the Economic Section at the U.K. Treasury and a distinguished Oxford development economist, and Sir James Mirrlees received the Nobel Prize in 1996.

In the 1970s, discounting became important as the country thought through how to respond to the oil price shocks: what were the requisite changes to its energy system? Though this was done in an era before the costs of carbon emissions were widely understood, the principles are still relevant. See J.E. Stiglitz, “The Rate of Discount for Cost-Benefit Analysis and the Theory of the Second Best,” *Discounting for Time and Risk in Energy Policy*, R. Lind (ed.), Baltimore: The Johns Hopkins University Press, 1982, pp. 151-204.

There have been various guidelines published on this topic for internal government use, see, for example: OMB Circular No. A-94, “Discount Rates to be Used in Evaluating Time-Distributed Costs and Benefits” (Mar. 27, 1972) and OMB Circular No. A-94, “Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs”, Oct. 1992.

productivity—far lower even than in the recent past—may decline still more.⁹⁶ Whether one agrees with Gordon’s assessment or not, this recent discussion has brought out four key points:

- a. There is considerable uncertainty about the pace of increase in living standards.
 - b. The pace of increase in living standards is endogenous—it depends on what actions we take.
 - c. If there is significant climate change, and if we continue on our current path, there is a significant risk of a decrease in standards of living.
 - d. The marginal value of consumption is likely to be high in those states of nature where climate change is greater, and where the adverse effects of climate change are large. That is to say, the value of additional consumption—the ability to build or consume more—and therefore its price will be higher when the effects of climate change are greater. Thus, in those places where the effects of climate change are most pronounced—where damage is the greatest and remediation need and costs are the highest—the *social cost* of such remediation will also be at its highest, exacerbating the damages to Youth Plaintiffs (both because when damages are high, the cost of remediation is also high, and because levels of consumption—what is left over after paying for remediation costs, and taking into account the damage done by climate change—are low).
76. It would be foolhardy—and wrong—for public policy to proceed as if there were no risk, either of a decrease in living standards, and especially of a lowering of those standards as a result of a failure to appropriately curtail emissions.
 77. Standard economics over the past half century has emphasized the importance of risk aversion, and that risk affects our actions. Common usage of discounting in public finance fails to take account of risk appropriately. When individuals are risk averse, they

⁹⁶ See, R.J. Gordon, *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War*, Princeton University Press, 2016. See also, R.J. Gordon, “Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds,” *NBER Working Paper*, No. 18315, August 2012, <http://www.nber.org/papers/w18315.pdf>.

are willing to buy insurance against a risk—to pay a considerable risk premium. This is also true for the business sector and society in general. This is especially important when we assess the appropriate response to the threat of climate change. The planet Earth cannot buy insurance from another planet against the risk of climate change here, but we can take precautionary actions. At the very least, this implies that the discount rate used for assessing climate change actions should be markedly different from that used for conventional short-term projects. As Chairman of the Council of Economic Advisers, I headed a review committee for the Office of Management and Budget (OMB) reviewing the guidelines for discounting, and that was the conclusion we reached in the late 1990s—that one must account for changes in relative price over time, and when our environment becomes more valuable in the future (i.e., as the value of preserving it becomes higher) that must be reflected in the economic analysis.⁹⁷ This was consistent with the position taken in the 2nd assessment of the IPCC, and in a paper I co-authored with the late Nobel laureate Kenneth Arrow and others.⁹⁸

78. More than half a century ago, President Johnson sent a message to Congress that we faced two paths: the cheaper option, in the short-term, of carrying down the path of pollution, or the more expensive option (at the time), of restoring the country and its natural heritage to the people.⁹⁹

We are able to see the magnitude of the choice before us, and its consequences for every child born on our continent from this day forward. Economists estimate that this generation has already suffered losses from pollution that run into billions of dollars each year. But the ultimate cost of

⁹⁷ Our report was issued in 1996: “Economic Analysis of Federal Regulations Under Executive Order 12866,” The White House, January 11, 1996, <https://obamawhitehouse.archives.gov/omb/inforeg/riaguide/>.

⁹⁸ K. Arrow, W.R. Cline, K-G. Maler, M. Munasinghe, J. E. Stiglitz, and R. Squitieri, “Intertemporal Equity and Discounting,” in *Global Climate Change: Economic and Policy Issues*, M. Munasinghe (ed.), World Bank Environment Paper 12, Washington, D.C. 1995, pp. 1-32. Reprinted in an abbreviated format as “Intertemporal Equity, Discounting, and Economic Efficiency,” *Climate Change 1995: Economic and Social Dimensions of Climate Change*, J. Bruce, H. Lee, and E. Haites (eds.), Cambridge: Cambridge University Press, 1996, pp. 125-144.

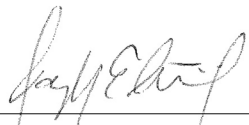
⁹⁹ “Preserving Our Natural Heritage,” Message from the President of the United States, transmitting “Programs for Controlling Pollution and Preserving our Natural and Historical Heritage,” February 23, 1966.

pollution is incalculable. We see that we can corrupt and destroy our lands, our rivers, our forests, and the atmosphere itself all in the name of progress and necessity. Such a course leads to a barren America, bereft of its beauty, and shorn of its sustenance. We see that there is another course more expensive today, more demanding. Down this course lies a natural America restored to her people. The promise is clear rivers, tall forests, and clean air – a sane environment for man.

79. For the last 50 years, Defendants have shirked from the “more demanding” course of restoring “America ... to her people.” Defendants’ policies that discount the future of Youth Plaintiffs and Affected Children at inappropriately high rates continue to steer America on the path of incalculable losses and away from that more demanding and sane course. The costs of fixing the damage today are much higher than they would have been in 1966 when President Johnson sent his message; but, the costs today are much lower than what they will be after another 50 years of fossil fuel pollution and inaction.

VI. CONCLUSION

80. The choice between incurring manageable costs now and the incalculable, perhaps even irreparable, burden Youth Plaintiffs and Affected Children will face if Defendants fail to rapidly transition to a non-fossil fuel economy is clear. While the full costs of the climate damages that would result from maintaining a fossil fuel-based economy may be incalculable, there is already ample evidence concerning the lower bound of such costs, and with these minimum estimates, it is already clear that the cost of transitioning to a low/no carbon economy are far less than the benefits of such a transition. No rational calculus could come to an alternative conclusion. Defendants must act with all deliberate speed and immediately cease the subsidization of fossil fuels and any new fossil fuel projects, and implement policies to rapidly transition the U.S. economy away from fossil fuels.
81. This urgent action is not only feasible, the relief requested will benefit the economy. More importantly, this action is necessary if Defendants are to prevent the extreme cost and damages Youth Plaintiffs and Affected Children are facing and will face to an even greater extent if Defendants continue on a path that does not account for what is scientifically necessary to protect the climate system they depend on for their future well-being and their personal and economic security.



Joseph E. Stiglitz, Ph.D.
April 13, 2018

Exhibit C:

Expert Report of Frank Ackerman, Ph.D.

**EXPERT REPORT
OF
FRANK ACKERMAN**

Principal Economist, Synapse Energy Economics

Kelsey Cascadia Rose Juliana; Xiuhtezcatl Tonatiuh M.,
through his Guardian Tamara Roske-Martinez; et al.,
Plaintiffs,

v.

The United States of America; Donald Trump,
in his official capacity as President of the United States; et al.,
Federal Defendants.

IN THE UNITED STATES DISTRICT COURT
DISTRICT OF OREGON

(Case No.: 6:15-cv-01517-TC)

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TABLE OF ACRONYMS AND ABBREVIATIONS

CO ₂ :	carbon dioxide
CBA:	cost-benefit analysis
DICE:	Dynamic Integrated Climate-Economy
FUND:	Climate Framework for Uncertainty, Negotiation and Distribution
IAM:	integrated assessment model
IWG:	U.S. Federal Government Interagency Working Group
kwh:	kilowatt hour
MWh:	megawatt hour
NAS:	National Academy of Sciences
OMB:	Office of Management and Budget
PAGE:	Policy Analysis of the Greenhouse Effect
PPA:	purchased power agreements
SCC:	social cost of carbon
VSL:	value of a statistical life
WTA:	willingness to accept
WTP:	willingness to pay

INTRODUCTION

I, Frank Ackerman, have been retained by Plaintiffs in the above-captioned matter to provide expert testimony regarding the economic consequences of human-caused climate change and the economic feasibility of a swift transition off of fossil fuels for energy. In this report, I examine multiple reasons why conventional economic analyses, such as those relied on by the Defendants, knowingly undervalue or dismiss the serious risks of climate damages that Defendants are in the process of imposing on the Youth Plaintiffs here and on future generations. These reasons include the standard approaches to discounting, the treatment of extreme risks and irreversible losses, reliance on flawed techniques of cost-benefit analysis, use of limited and often biased damage estimates, and specific choices made in calculating the “social cost of carbon” (SCC, i.e. the cumulative value of damages caused by a ton of CO₂ emissions). I also briefly discuss the surprisingly low, and declining, costs of emission reduction, which make active, large-scale climate protection policies more feasible.

As evidenced by my CV, I have written extensively about the economics of climate change, energy, and other environmental problems. I have particular expertise on the limitations of traditional cost-benefit analyses. I have written several books that address these issues, including *Worst-Case Economics: Extreme Events in Climate and Finance* (2017); *Climate Economics: The State of the Art* (2013); *Can We Afford the Future? The Economics of a Warming World* (2008); and *Priceless: On Knowing the Price of Everything and the Value of Nothing* (2004). I received my PhD in economics from Harvard University and have taught economics at the Massachusetts Institute of Technology, Tufts University, and the University of Massachusetts. I am a founder and member of the Steering Committee of Economics for Equity and Environment and a member scholar of the Center for Progressive Reform.

I also have significant professional experience in the private and nonprofit sectors, including work as: Principal Economist for Synapse Energy Economics, Inc. (2012 - present); Senior Economist and Director of Climate Economics Group for the Stockholm Environment Institute’s U.S. Center (2007 - 2012); and Senior Economist for the Tellus Institute (1985 - 1995). My clients have included the European Parliament, the U.S. Environmental Protection Agency, and the Environment, Economics and Society Institute. I have testified on the economic implications of global climate change to the United States Congress House Committees on Energy and Commerce and Ways and Means, and I have testified on energy and environmental concerns at a variety of state agency hearings.

This expert report contains my opinions, conclusions, and the reasons therefore. My CV, which includes a list of publications I have authored in the last ten years, is contained in **Exhibit A** to this expert report. In preparing my expert report and testifying at trial, I am deferring my expert witness fees to be charged Plaintiffs given the financial circumstances of these young Plaintiffs. If a party seeks discovery under Federal Rule 26(b), I will charge my reasonable fee of \$280 per hour for the time spent in addressing that party’s discovery. I have not provided previous testimony within the preceding four years as an expert at trial or by deposition. I have, however, provided expert witness testimony in several utility regulatory proceedings. My report contains citations to all documents that I have used or considered in forming my opinions, listed in **Exhibit B** to this expert report.

The opinions expressed in this expert report are my own and are based on the data and facts available to me at the time of writing, as well as based upon my own professional experience and

expertise. All opinions expressed herein are to a reasonable degree of scientific certainty, unless otherwise specifically stated. Should additional relevant or pertinent information become available, I reserve the right to supplement the discussion and findings in this expert report in this action.

EXECUTIVE SUMMARY

There are multiple grounds for believing that the economic analyses relied on by Defendants to inform climate and energy policy in the United States, knowingly underrepresent costs of climate disruption, thus undervalue the damage that Defendants are imposing on Youth Plaintiffs and future generations, and exaggerate the cost of reducing that damage today. One result of these biases is that the Obama Administration's estimate of the social cost of carbon ("SCC"), a measure of the severity of climate damages and the urgency of policy responses, was much too low, an affirmative step that placed these Youth Plaintiffs at significant risk. Defendants' underrepresentation and undervaluation of climate damages affirmatively placed these Youth Plaintiffs in a worse position than that in which they would have been had Defendants based their actions on recognition of the true costs, thereby predictably exposing these Youth Plaintiffs to the actual, particularized, and obvious dangers of climate disruption.

The treatment of discounting by Defendants frames their economic analysis of long-term problems such as climate change and has resulted in a policy or practice by Defendants that deliberately devalues the climate harms that Defendants know these Youth Plaintiffs will experience over the long term. Discount rates have immense influence on the results of economic analyses, particularly in an intergenerational context. How much less are future costs and benefits worth today, solely because they will occur in the future? If a high discount rate is used, the costs and benefits that will be experienced 100 years from now are worth almost nothing today, suggesting that climate mitigation (or other policies that benefit future generations) are not worth spending much on today. At a low discount rate, such as the 1.4% annual rate adopted by the Stern Review (Stern 2007), the present value of future impacts is much more substantial, endorsing policy-making as if the future mattered. Within the economic debates over discount rates, there are many strong rationales for very low, and even zero, discount rates. This is important because a very low discount rate is required in order to recognize the importance of climate impacts on future generations and their wellbeing in Defendants' climate and energy policy.

Cost-benefit analysis ("CBA") is a flawed economic framework for informing climate and energy policy, all too frequently biased against protecting the earth's climate and the needs of future generations. Some of the most ominous and important risks of climate change involve future risks and potential catastrophic and irreversible tipping points that may not be the most likely outcome but are nonetheless too likely to ignore. The framework of CBA, often applied to public policy evaluation today, relies on most likely, average, or expected (weighted-average) values for future risks and benefits. The CBA approach dismisses or devalues risks of extreme events and cannot accommodate climate impacts that become irreversible or unstoppable. An insurance framework provides a better way of thinking about catastrophic risks. Individuals who buy fire insurance or life insurance are typically insuring against events with annual probabilities of just a few tenths of a percent. Public policy modeled on insurance might focus on extreme risks which are about as likely as, or even more likely than, a residential fire or the death of a young parent (not impossible, but far from the most likely outcome), leading to a much more precautionary approach to climate and energy policy.

In addition to the issues of discounting and treatment of extreme risks, there are at least three fundamental problems with Defendants' application of CBA to climate and energy policy, all of which stem from the fundamental principle of CBA that requires a monetary value for every cost and every benefit – even those that are difficult or impossible to quantify.

- CBA is only meaningful if the estimates of costs and benefits are comparably complete – but this is almost never true in Defendants' evaluation of environmental policy. Costs of climate and environmental protection are generally matters of hardware and engineering estimates, which are easy to establish and meaningfully described in monetary terms. Benefits, in contrast, involve protection of life, health, nature, biodiversity, and other unmonetized, often unquantified, crucial values. Attempts at monetization of benefits are necessarily incomplete and approximate, to a much greater extent than on the cost side.
- Defendants' CBA analyses use the wrong information to measure the harm CO₂ emissions and unchecked climate change impose on individuals, families, and communities. When economists survey people to determine the value that the public places on environmental assets, they consider two perspectives. Willingness to pay ("WTP") asks what people would pay to avoid degradation of the asset, while willingness to accept ("WTA") asks what compensation people would accept for degradation. WTA would be appropriate if there is a right at issue – e.g., a property right or right to be free from harm – and polluters have to pay us to pollute; WTP would be appropriate if there is no such right, and we have to pay polluters to stop polluting. Both theory and experiment show that WTA is routinely higher than WTP, yet WTP has become the standard in CBA and climate economics, despite the fact that WTA would be more appropriate in the climate context.
- Since CBA demands prices for everything that matters, economists have invented prices for priceless values such as human life. These numbers do not play the same role as normal prices, however. Estimates such as \$9 million per life saved do not imply that you can buy a life, or the right to kill someone, for \$10 million. In the words of Immanuel Kant, some things we care about have a price, while others have a dignity. When evaluating policies and actions that encourage or discourage the development and use of fossil fuels, Defendants have not recognized that the benefits of climate protection include many things that have a dignity, which are literally priceless.

The conventional economic analyses relied upon by Defendants underrepresent costs of climate disruption. Within the existing methodology of cost-benefit-based federal government policy and the Obama Administration's SCC¹ calculations, there are specific data and analytical choices, which create additional biases against taking future climate risks seriously. In practice, economic assessment of climate policy has relied heavily on a handful of integrated assessment models ("IAMs"), namely DICE, FUND, and PAGE.² Inside each of these models, there is an assessment of the climate damages that are likely to occur as temperatures rise – the so-called "damage function". Calibration of the models' damage functions requires estimating the monetary value of damages at varying temperatures far above human historical experience.

¹ The social cost of carbon ("SCC") refers to the present value of the cumulative damages caused by an additional ton of carbon dioxide ("CO₂") emissions.

² FUND (Climate Framework for Uncertainty, Negotiation and Distribution), DICE (Dynamic Integrated Climate-Economy), and PAGE (Policy Analysis of the Greenhouse Effect) are the three IAMs relied upon by the federal government in estimating the SCC.

These damage functions are misleading, in part, because they have often been based on very dated sources and imply very small aggregate damages from the first few degrees of warming. A National Academy of Sciences review (NAS 2017) has called for the use of newer sources, and proposed a number of such sources. Moreover, these damage functions exclude significant and severe climate impacts, such as ocean acidification and species and wildlife loss, and some of the biggest potential risks of climate change, such as climate-induced migration and conflict, because these impacts and risks are extremely difficult to quantify.

The result of all these biases is that Defendants' estimate of the SCC under the Obama Administration, a measure of the severity of climate damages and the urgency of policy responses, is much too low. The Obama Administration's final estimate (the August 2016 technical revision of their 2013 estimate), converted to 2017 dollars, was \$49 per ton of CO₂ in 2020, rising to \$81 in 2050. These government estimates of the SCC seriously understate the harm that continued CO₂ emissions will impose on these Youth Plaintiffs and future generations. Many other sources exploring small changes in assumptions, or addressing uncertainties in the calculation, have come up with much higher numbers: frequently above \$100 today, and in some cases above \$1,000 by 2050.

The costs of solving the climate crisis are falling rapidly. In contrast to the risks of catastrophic changes in the earth's climate system and the ever-increasing damages and costs from the present inaction of government that perpetuates climate pollution, the costs of renewable energy technologies to reduce emissions have been plunging downward in recent years. It is now much cheaper than anyone expected just a decade ago to substitute carbon-free energy for fossil fuels. Wind power is fully competitive with other power sources in suitably windy areas, such as the Plains states, and solar power and battery storage are moving rapidly in the same direction.

In my expert opinion, Defendants have made deliberate decisions with respect to the economic analyses underlying climate and energy policy decisions, placing these Youth Plaintiffs at substantial risk of suffering serious harm, without taking readily available measures to abate that risk, even though a reasonable government official in the circumstances would have appreciated the high degree of risk involved—making the consequences of Defendants' conduct obvious. By not taking such measures, Defendants engaged in conduct that caused and continues to cause injury to these Youth Plaintiffs and future generations. Defendants have dismissed or devalued the serious harm from climate change that young people and future generations will experience, resulting in a policy and practice that discriminates against Youth Plaintiffs and future generations. In other words, Defendants' longstanding climate and energy policy in the United States knowingly underrepresented costs of climate disruption and was deliberately indifferent to a substantial risk of serious harm to these Youth Plaintiffs and future generations, and therefore caused harm (and is causing harm) to these Youth Plaintiffs and future generations.

EXPERT OPINION

My purpose in this expert report is to identify biases in Defendants' conventional economic treatment of the costs and benefits of climate and energy policies. I find that there are multiple reasons why the costs of enabling and maintaining the fossil fuel energy system are often understated, while the costs of rapid emission reduction and climate recovery have often been exaggerated. As a result, conventional economic analysis conducted by Defendants has incorrectly suggested that the benefits of rapid emission reduction are not large enough to justify its costs. This biased conclusion and the policies based on it discriminate against young people and put the welfare of future generations at risk, by allowing climate change to proceed with too little effort to reduce emissions and impacts.

I. Discounting devalues future climate harm

Under Executive Order 12866 (1993), federal agencies are required to conduct a cost-benefit analysis of all economically significant policies and regulatory alternatives, comparing actions that could be taken to the alternative of no change in the status quo. This clearly applies to climate and energy policies. Defendants' attempts to perform cost-benefit analysis of climate and energy policies lead immediately to the dilemmas of discounting future costs and benefits – and in practice, have led to a devaluation of future climate harms, and discrimination against Youth Plaintiffs and future generations.

Conventional economic analyses, underlying Defendants' climate and energy policies, provide an inappropriate framework for analyzing such policies, when the costs and benefits occur across multiple generations. Any evaluation of climate and energy policy costs and benefits must weigh the costs of emission reduction incurred today and in the near term against benefits (i.e., avoided climate damages) that stretch much farther into the future. Conversely, such an evaluation involves weighing the short-term economic benefits of not reducing emissions against the long-term damages and costs of climate harm. Climate change is a very long-term problem, spanning multiple generations and lifetimes. A significant fraction of carbon dioxide ("CO₂") emissions remain in the atmosphere for more than a century, continuing to heat up the earth. Even if emissions were to stop tomorrow, the CO₂ already in the atmosphere would continue to heat up the oceans for decades to come, causing an ongoing rise in sea levels as well as other impacts. (Hansen et al. 2013, 2015)

In this context, Defendants' use of the common economic practice of discounting devalues the serious harm from climate change that young people and future generations will experience in their lifetimes. In particular, Defendants' use of improperly high discount rates allows the short-term economic benefits of maintaining a fossil fuel-based energy system, combined with inaction (or insufficient action) on emission reduction, to outweigh the very severe long-term impacts in its cost-benefit analysis.

The standard practice in climate economics, as in many other areas of economic analysis, is to convert – or "discount" – future costs and benefits into their present values in today's dollars. The present value of a future amount is the amount that would need to be placed in a savings account today, at a specified interest rate, in order to end up with the target amount in the future year. Note that the result is crucially dependent on the discount rate, as the interest rate is called in present value calculations. The larger the discount rate, the smaller the present value of any

future amount. And the longer the time period, the greater the effect of changes in the discount rate.

These effects can be seen in **Table 1** below. At a discount rate of 1.5%, the present value of \$1,000 a century from now is \$226; at 3% it is \$52, and at 6%, it is merely \$3. Run the clock forward another century, and the present value of \$1,000 two centuries from now is \$51 at 1.5%, \$3 at 3%, or just \$0.01 at 6%.

In other words, at a low discount rate such as 1.5%, the present value of a cost or benefit 100 years from now is almost one-fourth of the future value. Even after 200 years, it retains some visibility, with a present value of \$51. On the other hand, at a 6% discount rate, costs and benefits 100 or 200 years barely matter today: the present value of \$1,000 drops to \$3 in one century, and to just a penny in two centuries. At 6% it is hard to “see” the future; it shrinks by five orders of magnitude in 200 years. A 3% rate, intermediate between these extremes, still belittles the far future, reducing \$1,000 to a present value of \$3 in 200 years. Even at a rate of 3% – the rate used in Defendants’ SCC under the Obama Administration – long-term climate consequences are largely hidden by discounting.³

Table 1. Present value of \$1,000 payment in future years

<i>Years from now</i>	<i>Discount rate</i>		
	<i>1.5%</i>	<i>3%</i>	<i>6%</i>
100	\$226	\$52	\$3
200	\$51	\$3	\$0.01

Source: Author’s calculations. Amounts, except \$0.01, rounded to nearest dollar.

Discounting does have appropriate applications. Using a market interest rate, discounting is appropriate for private financial decisions within a single lifetime. The present value of the entire stream of payments due on a mortgage, car loan, or student loan, discounted at the rate at which one borrowed the money, is simply the amount that one borrowed. If one has the option of making an investment with a known payoff at a fixed future date, one would be well-advised to compare the present value of the payoff to the cost of the investment today, discounting the payoff at the interest rate available on savings accounts or other risk-free investments. If the present value of the payoff is less than the cost of the investment today, one would be better off leaving the money in the bank.

However, the same logic does not apply to intergenerational decisions about public goods. There is no one person who will experience and compare both costs of climate and energy policy incurred today and benefits of that policy experienced a century or more from now. And in any

³ Defendant EPA recognizes the serious equity considerations of discounting in an intergenerational context in its Guidelines for Preparing Economic Analyses: “compounding interest over very long time horizons can have profound impacts on the intergenerational distribution of welfare. An extremely large benefit or cost realized far into the future has essentially a present value of zero, even when discounted at a low rate.” (EPA 2010)

case, the benefits accrue to everyone worldwide, not solely to the descendants or fellow citizens of those who pay the costs today. Thus, as many economists would agree, the discount rate for climate analysis is at least in part an ethical decision, expressing our beliefs today about the value of the lives and wellbeing of young people and future generations, and the environment that we are leaving to them. If our impacts on future generations matter, then the appropriate discount rate for climate costs and benefits needs to be very low, probably near zero, an argument made effectively in the Stern Review (Stern 2007), and other sources.

There are two major approaches to calculating the discount rate for climate analysis, known as the descriptive and prescriptive approaches (for the classic presentation of these approaches, see Arrow, Cline *et al.* 1996). The descriptive approach asserts that the discount rate should be based on the rate of return on assets in financial markets; the prescriptive approach develops a discount rate from principles of economic theory, ultimately including normative judgments about the weight that should be given to the utility and welfare of future generations. Arguments can be made within either framework for adopting a near-zero discount rate.

The descriptive approach argues that rates of return in financial markets must be the relevant standard, even for long-term climate analyses, since we have a choice between investing in climate mitigation or investing the same amount in financial assets held in trust for future generations. The idea is that discounting future impacts at the market rate of return will tell us which choice is worth more for our descendants.

However, there are multiple rates of return on financial assets varying, among other characteristics, in their level of risk. Stock markets, with relatively high rates of risk, have high rates of return, often estimated at 6% or more in the long run. Use of such a high discount rate would amount to ignoring the far future, as suggested by Table 1 above. On the other hand, virtually risk-free assets such as government bonds have much lower rates of return, and risk-reducing assets such as insurance policies have negative rates of return (in every year when you do not file a claim for payment under the policy).

Investing in climate mitigation most closely resembles investing in risk-neutral or risk-reducing financial assets, in the face of uncertain but extreme climate risks. If expenditure on climate mitigation is virtually risk-free, or perhaps even risk-reducing, the descriptive approach might imply that its costs and benefits should be discounted at a risk-free or risk-reducing rate – perhaps 1.5% or less. As Table 1 demonstrates, a rate of 1.5% implies that far-future impacts remain significant in present value, and hence, should influence policymaking today.

The prescriptive approach, in contrast, separates the question of the appropriate discount rate into two parts. The first part is based on the assumption of rising income levels, and the second would apply if every generation had equal resources.⁴ Regarding the first part: if we assume future generations will be richer than we are today, each additional dollar will be worth less to them than it is to us. One part of the prescriptive discount rate is therefore based on the projected

⁴ Theoretical analysis identifies a third part based on the year-to-year variation (in technical terms, the variance) of growth rates. This is frequently omitted in applied analyses, since it is difficult to forecast the variance of growth rates, and numerical simulations suggest that this third term may be small.

growth rate of per capita consumption.⁵ This part is generally less controversial among economists; however, it is important to note that by the same logic, if future generations are poorer than we are, due to climate-induced losses or any other cause, then the same amount of money is worth more to them than to us, so this part of the discount rate should become negative. This is an important but often overlooked argument for very low discount rates when evaluating the worst potential climate outcomes.

The second part of the discount rate under the prescriptive approach is the rate that would be appropriate if we knew that every generation would have the same per capita resources. This is often referred to as the rate of pure time preference. Its value is a matter of ethical judgment – and of unresolved controversy. A positive rate of pure time preference implies that we judge the contribution of future generations to social welfare to be less than ours. In effect, it represents discrimination by date of birth. Concern about the ethics of this judgment is not new in economics, as acknowledged by the Federal Government’s Interagency Working Group (“IWG”) on the Social Cost of Carbon: “Ramsey (1928), for example, has argued that it is ‘ethically indefensible’ to apply a positive pure rate of time preference to discount values across generations, and many agree with this view.” (IWG 2010) The Stern Review argued that intergenerational equity – i.e. taking future generations seriously – requires a near-zero rate of pure time preference.⁶ Combined with a low estimate of future growth rates, this led Stern to use a discount rate of 1.4%, close to the lowest rate shown in Table 1.

In summary, while debate continues on the merits of descriptive versus prescriptive approaches to discounting, and on the numerical values to be used, strong arguments have been made for a very low discount rate under either approach, if a cost-benefit analysis is performed at all. This is important because a very low discount rate is required in order to recognize the importance of climate impacts on future generations and their wellbeing, as suggested by Table 1.

Low values such as the Stern Review discount rate of 1.4% have been endorsed by many economists. For example, Nicholas Stern (2007), Geoffrey Heal (2009), Chris Hope (Johnson and Hope 2012), Martin Weitzman (1998), William Cline (2004), John Broome (1992), Paul Kelleher (2012), and myself (Ackerman and Finlayson 2006), among others, have all expressed opinions that the discount rate applied to long-term climate change damages should be lower than the 3% rate assumed by the IWG.

The Trump Administration’s March 28, 2017 Executive Order rescinding the social cost of carbon (“SCC”) continues the government practice of using high discount rates, which knowingly results in policies that are dismissive of future impacts. The Executive Order states: “when monetizing the value of changes in greenhouse gas emissions resulting from regulations, including with respect to the consideration of domestic versus international impacts and the

⁵ In a discount rate based on the prescriptive approach, the growth rate of consumption is multiplied by a parameter expressing how fast a fixed sum of money loses value to us as we become richer; in practice, that parameter is often assumed to be in the range of 1 to 3.

⁶ A value of exactly zero leads to mathematical problems in formal modeling, and perhaps to implausibly strong implicit bias against the needs of the current generation. Stern (2007) proposed a rate of pure time preference of 0.1%, based on the assumption that we have an annual probability of 0.1% of destroying the human species. For Stern, all generations are of equal ethical importance if they exist, but next year’s population is only 99.9% as important as this year’s, due to its slightly lower probability of existence, and so on.

consideration of appropriate discount rates, agencies shall ensure, to the extent permitted by law, that any such estimates are consistent with the guidance contained in OMB Circular A-4 of September 17, 2003 (Regulatory Analysis).⁷ Circular A-4 describes the longstanding practice and policy in government regulatory analyses of assessing policies using both a 3% and a 7% discount rate. Whatever the historical merits of these rates, or the impacts in other arenas, in my opinion, they are far too high for sensible analysis of climate and energy policy. Even the use of a 3% discount rate – the rate used in Defendants’ SCC under the Obama Administration – amounts to a dismissal of the impacts on future generations caused by present CO₂ emissions, compared to the lower rates used in the Stern Review and elsewhere. The discount rates mandated by the March 28, 2017 Executive Order continue to effectuate discrimination against future generations and children who will live into the second half of the century. By utilizing these inappropriately high discount rates, Defendants made a deliberate decision to be indifferent to the impacts on future generations caused by present CO₂ emissions, objectively knowing such impacts are substantially certain to result in continued and increased harm to the wellbeing and personal security of these Youth Plaintiffs and future generations.

II. Extreme risks and worst cases

Cost-benefit analysis requires a monetary value for every cost and every benefit – even those that are difficult or impossible to quantify. In the face of uncertainty, CBA requires an average, expected value, or most likely outcome. But the most worrisome consequences of climate change are the risks of catastrophic, irreversible changes for the worse, at times in the future that cannot be precisely predicted. Faced with catastrophic risks, most people do not think in terms of cost-benefit analysis; instead, they often buy insurance, even though they hope they will never need to use it. (This section of my report is based on the extended discussion of uncertainty and worst-case risks in Ackerman 2017.)

Consider the purchase of fire insurance. Public fire departments across the United States responded to 370,000 residential fires in 2013, while there were 133 million housing units in the country.⁸ At that rate, the average housing unit has a fire large enough to report to the fire department once every 360 years. The annual number of fires is less than 0.3% of the number of housing units, so you have better than 99.7% confidence that you will not use your fire insurance next year. The most likely number of fires anyone will experience in a lifetime is zero.⁹

⁷ Presidential Executive Order on Promoting Energy Independence and Economic Growth, Sec. 5, March 28, 2017, <https://www.whitehouse.gov/the-press-office/2017/03/28/presidential-executive-order-promoting-energy-independence-and-economy-1>

⁸ Fire data from National Fire Protection Association, “Fire Loss in the United States During 2013,” <http://www.nfpa.org/~media/files/news-and-research/fire-statistics/overall-fire-statistics/fireloss2014.pdf?la=en>. Housing unit data from the Census Bureau’s American Housing Survey 2013, <http://www.census.gov/programs-surveys/ahs/data/2013/national-summary-report-and-tables---ahs-2013.html>.

⁹ The National Fire Protection Agency similarly concluded that a household has a one in four chance of a fire reported to a fire department during an average lifetime. <http://www.nfpa.org/research/reports-and-statistics/fires-by-property-type/residential/a-few-facts-at-the-household-level>. If the annual probability of a fire is 0.3%, there is a one in four chance of a household having a fire every 95 years.

Much the same applies to life insurance, which is frequently purchased by young parents. The chance of dying next year is under 0.2% for the average American until age 40, and under 1% until age 60.¹⁰ When homeowners buy fire insurance and young parents buy life insurance, they are expressing concern about potential personal disasters with probabilities of a few tenths of a percent per year.

Despite the fact that an insurance policy will lose money for the average policyholder, the worst-case outcome is bad enough to make it seem worthwhile. Even without knowing the exact probabilities of the ominous risks associated with climate change, future catastrophic outcomes are becoming more likely with every day we continue on a business-as-usual emissions trajectory, and delay serious emission reductions. Considering this, it makes sense to take catastrophic climate risks much more seriously, and to seek forms of collective self-insurance or protection against those risks (since there is no galactic insurance company that can write a policy covering damage to the only planetary climate we own).

In fact, the problem is more difficult than a decision to buy insurance, since we do not know the probabilities of worst-case outcomes. This leads to several unexpected results. For example, the Harvard economist Martin Weitzman (2009) proved what he called the “Dismal Theorem” of climate economics: the expected value of the benefits from emission reductions is literally infinite, essentially because worst-case scenarios could approach or include human extinction, and uncertainties regarding the probability of worst-case scenarios make it impossible to rule out those worst cases with sufficient confidence.¹¹

Another strand of economic theory analyzes choices under deep uncertainty, where the range of possibilities is known, but nothing is known about their exact probabilities. Kenneth Arrow and Leonid Hurwicz, two well-known theorists who each won the Nobel Prize in economics, proved that if the possibilities are known but the probabilities are unknown, the ideal policy decision is based only on the best and worst possible outcomes (Arrow and Hurwicz 1972). Later work based on their result has shown if society is risk-averse or wants to keep its options open, only the worst case matters for choosing the best policy (Kelsey 1993, Gilboa and Schmeidler 1989).

There is a secondary problem of determining whose forecasts of risks are credible, which may be particularly important in the age of Internet rumors and fake news. But the message of the Arrow-Hurwicz result and related later work is crucial for climate and energy policy: in the presence of inescapable uncertainties, policy should be based on the credible worst-case outcome. This, of course, entails rapid reduction in emissions to minimize the all-too-credible risks of abrupt, irreversible tipping points and catastrophic changes in the earth’s climate. (Hansen et al. 2013, 2015) However, Defendants have not integrated these concerns about worst-case outcomes into their climate and energy policies and actions. The result is a theoretically unsound and dangerous bias favoring policies and actions that will increase the disproportionate climate damages and financial burden borne by these Youth Plaintiffs and future generations.

¹⁰ Based on all-cause mortality rates for 5-year age brackets, calculated from Arias (2014), Table B.

¹¹ See also discussion of Weitzman’s Dismal Theorem in Ackerman (2017), pp. 127-129.

III. Why not cost-benefit analysis?

Since the beginning of the Reagan Administration, the Federal Government has been required to conduct a cost-benefit analysis (“CBA”) for any significant regulatory action, to ensure that the action is worth doing.¹² In addition to the problems related to discounting and responding to extreme but uncertain risks, there are multiple, fundamental flaws in CBA as it has been practiced in Defendants’ recent policy analysis. Here I will discuss three factors that make CBA inappropriate for climate analysis¹³, and for many other environmental analyses as well:

- Asymmetry and incomplete monetization of benefits vs. costs;
- Use of willingness to pay (WTP) rather than willingness to accept (WTA) for valuations of environmental benefits and fundamental human rights; and
- “Pricing the priceless” – the morally ambiguous improvisations at the heart of the CBA process for human rights and environmental concerns.

A. Asymmetry and incompleteness

A hidden assumption of the cost-benefit comparison is that the calculations of costs and benefits are comparably complete. The calculation explicitly mimics the decision-making of a business comparing its costs and revenues; a product is profitable if and only if revenues exceed costs. Note that this calculation is biased and unreliable if either the costs or the revenues are incomplete. A business that compared complete costs to a partial accounting of revenues could miss profitable opportunities for investment. The opposite mistake, comparing partial costs to complete revenues, could lead to missing the signals that the company is losing money.

CBA of climate, energy, or other environmental policies is typically imbalanced and biased, providing a relatively complete accounting of costs, versus an incomplete and problematical accounting of benefits. On the cost side, environmental protection usually requires spending money on technologies and activities with well-defined, easily discovered market prices. For example, it may be possible to document the costs of emission reduction for the electric power system, transportation, and other sectors.

In contrast, the CBA process for climate and energy policy is very likely to have only a partial accounting and valuation of benefits.¹⁴ Analysts may not recognize or include all the benefits of,

¹² This requirement first appeared on February 17, 1981, in President Reagan’s Executive Order 12291 and has been updated and continued by subsequent Executive Orders under more recent administrations.

¹³ Defendant EPA has confirmed this conclusion in a 2008 report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, “Analyses of the effects of global change on human health and welfare and human systems.” The report stated: “the economic approach [to human welfare], when interpreted as requiring a strict cost-benefit test, is not appropriate in all circumstances, and is viewed by some as controversial in the context of climate change [due to considerations of intergenerational equity and ‘potential irreversible consequences’]. Benefit cost analysis is one tool available to decision makers; in the context of climate change; other decision rules and tools, or other definitions of welfare, may be equally, or more relevant.” (Sussman et al. 2008)

¹⁴ The Office of Management and Budget in its 2003 guidance on Regulatory Analyses explains how this can be misleading: “When important benefits and costs cannot be expressed in monetary units, [CBA] is less useful, and it can even be misleading, because the calculation of

for example, the immense health benefits from the cleaner air that results from reduction of greenhouse gas emissions¹⁵, or the multiple ecological services that forest protection can provide. The benefits of climate policy include protection of human life, health, many dimensions of the natural environment, biodiversity, ecosystem services, and other non-market values, such as aesthetic, cultural, and spiritual values. Prices can be deduced for some of these values, but not all; construction of artificial prices for human life and nature is a controversial process requiring significant time and expense. (This differs from market prices, which are available to all with little or no cost of acquiring information.) Additional problems with the construction of prices for priceless values are discussed in subsection C below.

Moreover, if the value of benefits cannot be estimated, Defendants' default value is zero. The adversarial context of CBA for government policy insists that if a monetized value for a non-market benefit cannot meet very high standards of rigor and certainty, it must be treated as if it were zero.¹⁶ Analysts often try to describe in qualitative terms the benefits that they could not monetize, surrounding the numbers with extensive verbal accounts and multiple caveats. This prose can vanish in the policymaking process, which often acts as a "caveat-stripper": lose the words, keep the numbers. When this occurs, all information is lost about important benefits that the analysts identified but could not monetize. The result is an impoverished discourse about climate impacts, and an underestimate of the costs of climate harm and the benefits of emission reduction – contributing to the bias Defendants have shown toward policy decisions that perpetuate the harm to these Youth Plaintiffs and future generations.

Due to the problem of asymmetry and incompleteness in any CBA of climate and energy policy, we are left with a comparison of relatively complete costs and much more incomplete monetized benefits – and therefore a meaningless bottom line.

B. Who pays whom?

In the attempt to monetize non-market values, economists often end up surveying people about what those values are worth to them. It is worth noting at the outset that this method cannot measure the value to children of health and environmental protection.¹⁷ For adults, economic value can be expressed in either of two ways: the most a person is willing to pay ("WTP") to obtain a benefit or item that they do not now have, or the minimum amount a person is willing to

net benefits in such cases does not provide a full evaluation of all relevant benefits and costs." (OMB 2003).

¹⁵ For a review of the rapidly expanding literature on health co-benefits of greenhouse gas emission reduction, see Gao et al. (2018).

¹⁶ This is the effect, though not the stated intent, of the 1993 Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993), setting extremely high standards for admissible evidence in regulatory analyses. As a result of *Daubert* and related standards, "pressures for ever-increasing documentation, review, and 'sound science' have been used to create unreasonable standards of evidence, interfering with the government's task of protecting the public." (Neff and Goldman 2005)

¹⁷ The Office of Management and Budget in its 2003 guidance on regulatory analyses points out that the valuation of health and safety risks to children and infants "poses special challenges" stating that "[i]t is rarely feasible to measure a child's willingness to pay for health improvement." (OMB 2003).

accept (“WTA”) for giving up a benefit or item that they currently have. Some simple economic theories have suggested that at the margin, the two should be the same.

However, both theory and experiment now confirm that there can be a wide gap between WTP and WTA measures, with WTA routinely larger than WTP. In theory, the gap between the two depends, in part, on whether there are any close substitutes available for the benefit in question, with very wide gaps possible for irreplaceable benefits (Hanemann 1991). In practice, one of the classic experiments of behavioral economics shows that even for ordinary, easily replaced items, WTA can be greater than, and often twice as large as, WTP.¹⁸

For CBA, economists have standardized on WTP measures of non-market values, perhaps because they are easier to calculate, or avoid problems of very high, even infinite valuations (Arrow, Solow *et al.* 1993). In any carefully framed and conducted study, no one’s WTP can meaningfully exceed their income or assets, whereas people could logically demand much more than their own resources to accept environmental degradation. In fact, a refusal to accept environmental loss or loss of fundamental rights like personal security at any price, a legitimate, perhaps common, preference, could show up as an infinite WTA.

Climate mitigation benefits, or conversely losses from unchecked climate change, frequently involve irreplaceable gains or losses, where WTP and WTA would be expected to differ most widely. The choice between these two methods, in effect, is a question of rights and ownership: is the public buying natural assets or pollution abatement from polluters, at the WTP rate? This assumes that polluters own the environment and have the right to pollute. Or are polluters buying the opportunity to pollute from the public, at the WTA rate? The latter option assumes that the public owns the environment, and has the right to refuse pollution and be free from harm. Whatever the historical origins of the practice, standardization on WTP valuations in CBA amounts to asserting that the public has to buy nature from the polluters – a choice that lowers the value assigned to climate protection.

To make this more concrete, consider the plight of Levi, the youngest of the Youth Plaintiffs in this case, a child who lives on a barrier island off the coast of Florida. His WTP to avoid sea-level rise that would destroy his home and the surrounding beach is presumably limited to some fraction of his limited assets. His WTA value for destruction of his home and community could be very large, even infinite. Use of WTP reinforces inequality, since wealthier communities are willing to pay more, “justifying” greater protection for them. Moreover, the WTP approach implicitly asserts that Levi and his neighbors may have to buy the right to continue living where they do, from polluters who would profit by contributing to their community’s destruction.

C. Pricing the priceless

Many of the benefits of climate and environmental protection are difficult to value because they consist of saving human lives, preventing extinction of species, and other non-marketable goals.

¹⁸ A group of college students were randomly given either a mass-produced coffee mug decorated with their college insignia, or an amount of money equal to the market price of the mug, and then invited to trade with each other. WTA, i.e. the price at which those who were given mugs were willing to sell them, averaged about twice as much as WTP, the amount that those who received cash would pay for a mug. This general pattern has reportedly been found in a number of other settings (Kahneman 2011).

Since air pollution kills many people, the value of each life saved is crucial to valuation of the benefits of pollution reduction. For CBA purposes, it has become common to assume values around \$9 million per life saved (often called the “value of a statistical life”, or VSL) in the United States. Regulations that save lives at less than \$9 million apiece pass a cost benefit test; those that cost more than \$9 million per saved life fail the test.

This monetization of a human life at \$9 million does not mean, however, that you can buy the right to kill someone for \$10 million. Even stranger is the alternative, favored by some analysts, of individually valuing each year of life saved; since everyone will eventually die, the argument goes, all we are doing is saving life-years. But assigning a fixed dollar value per saved life-year suggests that, contrary to all major ethical and religious beliefs, it is a lesser crime to kill an older person.

The urge to monetization has mis-framed the question of the value of life. Figures such as \$9 million per life saved are built up from small risks, such as \$9 WTP to avoid a one-in-a-million risk of death. But imagine one million people, all facing a one-in-a-million risk of death. On average, all but one of them will survive, although experiencing that \$9 risk. Those risks to the 999,999 survivors total almost \$9 million in value, amounting, in round numbers to the value of one “statistical life.” One of the million people, on average, will not survive; that person’s much worse experience is not meaningfully addressed by the \$9 WTP value nor the \$9 million VSL.

WTP to avoid small fractional risks of premature death can, arguably, place a value on risks experienced by those who survive. It cannot, however, value life itself, which has no meaningful monetary price. As the philosopher Immanuel Kant said long ago, some things have a price, while other things have a dignity (Kant 2005 [1785]).

The same is true of the natural world and the valuation of non-human species. A study, some years ago, found that U.S. households were willing to pay a total of \$18 billion to prevent the extinction of humpback whales.¹⁹ This does not mean that anyone would have welcomed an offer of \$20 billion for the opportunity to hunt humpback whales to extinction. Rather, the \$18 billion WTP value was an inarticulate statement of the fact that people value the survival of whales very highly; the number itself has no real meaning. Whales, too, as sentient beings and thus proper objects of our moral concern, have a dignity, and not a price.

A final, jarring example of an attempt to monetize the priceless came in a Department of Justice study, which chose to conduct a CBA of the Prison Rape Elimination Act. The study, which was clearly not required by law, has been praised by prominent CBA advocates (Sunstein 2014). A centerpiece of the study was the value of an avoided rape, reportedly \$310,000. Resembling the problems with the value of a statistical life, the number apparently came from a survey asking people how much they would pay to live in a neighborhood with fewer rapes. Once again, it is a value of avoiding small risks experienced by those who do not suffer the horrific event being evaluated. The assigned price again illustrates the poverty of thinking underlying traditional CBA. Freedom from violence also has a dignity, and that too should not be ignored simply because it is not susceptible to accurate pricing.

Climate mitigation is full of parallel cases: policies that will protect human lives, species at risk, public trust resources, and other priceless values such as these Youth Plaintiffs’ fundamental

¹⁹ See the account in Ackerman and Heinzerling (2004).

constitutional rights. However, these priceless benefits from climate mitigation are deliberately not reflected in Defendants' climate and energy policies or actions. The invented imperative of cost-benefit analysis neither justifies nor renders rational the assignment of prices to human lives and other matters of intrinsic concern. They are worth protecting because of their dignity, not their invented prices. But if all you have is a calculator, everything looks like a number.

IV. The social cost of carbon: Getting the numbers wrong

Economic analysis of climate damages is often summarized in estimates of the social cost of carbon ("SCC"), defined as the present value of the present and future damages caused by emission of one additional ton of CO₂. The previous sections of this expert report identified many reasons why such numerical estimates are likely to be incomplete and understate the true extent of climate damages. This section explores recent calculations of the SCC in greater detail, focusing on the models used in the federal Interagency Working Group ("IWG") calculations in 2010 and 2013 (IWG 2010, 2016).

Economic theory describes environmental damages as negative externalities, or costs that market transactions impose on uninvolved third parties. For example, the Plaintiffs in this case, and others of their generation and their descendants, were neither the buyers nor the sellers of fossil fuels that caused most of the harm to the climate. The theoretical remedy, known since the work of Arthur Pigou (1920), is that the costs of externalities should be internalized, or included in the price of activities that cause emissions. This would force buyers and sellers to recognize the true costs of emissions, and would decrease demand.

If the SCC were an accurate measure of climate damages, then it could be incorporated into prices of fossil fuels (and other sources of CO₂), sending a strong price signal about the need to cut back on these fuels and their associated emissions. In practice, this has never been done for the economy as a whole, although many Obama Administration regulatory analyses included the IWG's SCC estimate for the value of carbon emissions. For example, this added to the calculated benefits of vehicle fuel economy standards, since those standards (modestly) reduced fuel use and vehicle emissions. (Conversely, the Trump Administration's abandonment of the SCC means that there is a complete lack of internalization of climate externalities; continuing the same example, the calculated benefits of vehicle fuel economy standards would now be lower, with the cost of carbon emissions effectively valued at zero.)

The IWG's analyses averaged the results from slightly modified versions of three integrated assessment models ("IAMs"), known as DICE, PAGE, and FUND. IAMs offer "integrated" calculations of the future evolution of the global economy and climate, at a very simplified level. The three chosen models are perhaps the best-known IAMs, but not necessarily the most accurate, and certainly not the most detailed. A 2017 review by the National Academy of Sciences (NAS 2017) identifies numerous weaknesses in these three models, and makes many suggestions for improvement.

A. Damage functions and dated research

IAMs rely on a "damage function" – a mathematical representation of the damages expected as temperatures and sea levels rise. The creation and validation of a damage function is difficult, as it describes climate-related losses expected under conditions that are outside our historical experience. Nonetheless, there is a certain amount of research bearing on this subject. As the

National Academy of Sciences review (NAS 2017) points out, the three IAMs used by the IWG, namely DICE, PAGE, and FUND, rely on dated research.

FUND, the one of the three models with the most disaggregated damage calculations, relies heavily on estimates of climate damage from the 1990s. According to NAS (2017), FUND version 3.8, used in the 2013 IWG calculation, relied on 27 sources for its damage estimates – 18 of them published in the 1990s.²⁰ This is potentially important because FUND consistently produces the lowest estimate of climate damages among the three models relied on by the IWG, reducing the SCC (which is calculated as a three-model average). FUND's agricultural estimates, drawing on 1990s research, project net global benefits from the first few degrees of warming, offsetting damages in other sectors (Ackerman and Munitz 2012, 2016). Newer research is available, often projecting a more ominous picture of damages in agriculture from near-term climate changes. Indeed, the NAS review offers a list of 30 sources, published from 2007 to 2016, which could be used to update climate damage estimates relied on by FUND.²¹

DICE and PAGE also understate the cost of climate damages, but offer less detailed development of their damage estimates. The latest version of DICE (newer than the one used by the IWG), DICE-2016R, bases its damage estimates on a recent (apparently unpublished) literature review by William Nordhaus and a coauthor. According to Nordhaus, the economist who developed DICE, the damage function in DICE-2016R implies global climate damages equal to 2.1% of income at 3°C of warming, and 8.5% of income at 6°C (Nordhaus 2017, supplementary information). At recent U.S. growth rates, this means that 3°C of warming would cause damages equal to the loss of less than 18 months of economic growth, equivalent to taking us back to the economy of early 2017, while the damages from 6°C would be equivalent to losing less than 5 years of growth – the same as busting us all the way back to 2013. At China's much faster growth rates, even 6°C would cause losses of less than 18 months of growth, sending the Chinese economy back to early 2017.

Whatever the source of the DICE damage estimates, they appear to trivialize the risks of significant warming. In his recent writing, Nordhaus has emphasized unquantifiable impacts and risks of irreversible extreme events (Nordhaus 2013). But the damage function in his model lags behind his qualitative descriptions of climate risk, helping to perpetuate an understatement of the cost of emissions.

Defendants, through the IWG (in both 2010 and later revisions), recognized the many sources of uncertainty and important limitations of the IAMs relied upon for the SCC. The IWG admitted that the IAMs do not include “all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature” due to a “lack of precise information on the nature of damages and because the science incorporated into these models understandably lags behind the most recent research.” (IWG 2010, 2016) Importantly, the IWG recognized its complete inability to monetize, and thus omission, of significant and severe climate impacts: “even in future applications, a number of potentially significant damage categories will remain non-monetized. (Ocean acidification is one example of a potentially large damage from CO₂ emissions not quantified by any of the three models. Species and wildlife loss is another example that is exceedingly difficult to monetize.)” (IWG 2010)

²⁰ See NAS (2017), Table 5.2. Two of the nine “newer” sources for FUND 3.8 were review articles by one of FUND's developers, published in 2002.

²¹ NAS (2017), Table 5.3.

In addition to the complete omission of these severe damages from the SCC estimates, the IWG noted other sources of uncertainty that have not yet been fully quantified in the IAM's, and thus Defendants' SCC estimate under the Obama Administration, including potential catastrophic damages due to "tipping points" in Earth systems with "potentially severe social and economic consequences" and "inter-sectoral and inter-regional interactions, including global security impacts of high-end warming." (IWG 2010, 2016)

The IWG also explained the risks of using conventional economic analysis and assumptions in the context of climate change: "The three IAMs used here assume that it is possible to compensate for the economic consequences of damages to natural systems through increased consumption of non-climate goods, a common assumption in many economic models. In the context of climate change, however, it is possible that the damages to natural systems could become so great that no increase in consumption of non-climate goods would provide complete compensation. . . . For instance, as water supplies become scarcer or ecosystems become more fragile and less bio-diverse, the services they provide may become increasingly more costly to replace." (IWG 2010)

B. Published estimates of the SCC

There is a wide range of published estimates of the SCC, many of them much higher than the estimates the IWG proposed for use in U.S. government cost-benefit analyses. The federal IWG's final revision, in August 2016, put the SCC, in 2017 dollars, at \$42 per metric ton of CO₂ in 2015, rising to \$49 for emissions in 2020 and \$81 in 2050 (IWG 2016).²² The IWG offered two variants on its own work that implied much higher values: reducing the discount rate from 3% to 2.5% would raise the SCC by about 40%, while using much higher climate sensitivity (implying much greater long-term warming from the same level of greenhouse gases in the atmosphere), at a 3% discount rate, would roughly triple the SCC.²³

Several SCC calculations have been done with DICE, after making minor modifications to the model. In my own work, coauthored with Elizabeth A. Stanton, we explored combinations of four changes to DICE: lowering the discount rate to 1.5%, adopting much higher climate sensitivity, and making two adjustments to the DICE damage function, one of which was based on Martin Weitzman's suggestion of 50% loss of global income at 6°C and 99% loss at 12°C (Ackerman and Stanton 2012). With four independent changes to the DICE defaults, we produced 16 variants on the SCC. Our estimates for the SCC in 2050, converted to 2017 dollars, ranged from \$75 to \$1,824 per metric ton of CO₂. The point is not that we know the SCC will be over \$1,800 in 2050; rather, we do not know with any reasonable level of confidence that the

²² The basic modeling was done by the IWG twice, in 2010 and 2013. Several technical updates made minor corrections to the 2013 estimate after publication. The results were published in 2007 dollars, and have been multiplied by 1.177 to convert to 2017 dollars, based on the increase in the Consumer Price Index. The figures here are the so-called "central estimate", based on a 3% discount rate and median climate sensitivity.

²³ Results were not provided for the combination of these two innovations. Another set of IWG calculations raised the discount rate to 5%, resulting in an SCC of about one-third of the "central estimate". For the reasons I have explained above, estimates of the SCC using a discount rate this large are not appropriate for Defendants' climate and energy policies and actions.

SCC will not be that high. The range of uncertainty in the DICE SCC, considering only the four changes we examined, is more than twenty-fold (i.e., \$1,824 is more than 20 times \$75).

In Nordhaus' latest work (Nordhaus 2017), using a newer version of DICE than used in my research, or in the IWG calculations, he finds that in his most severely climate-constrained scenario, the SCC rises from \$207 in 2015 to \$1,129 in 2050.²⁴ For another analysis that finds that revision of the DICE damage function can cause a large increase in the estimated SCC, see Howard and Sterner (2017). Yet another analysis, using an older version of DICE, modified to include the risks of multiple tipping-point catastrophes, found that those risks increased the SCC to \$130 in 2017 dollars (Cai et al. 2016).

Chris Hope, the developer of the PAGE model, has also estimated the SCC to be higher than the government's calculation. Hope has published an analysis of the SCC implied by his PAGE09 model (Hope 2011). His preferred estimate, using his default values, is equivalent to \$151 in 2017 dollars.²⁵ PAGE has always been the source of the highest SCC estimates in the IWG process, but the estimate using Hope's preferred values is even higher than the IWG's modified PAGE values.

Surveys of scientists and economists show broad agreement that the IWG's SCC is too low. Robert Pindyck (2016) surveyed several hundred climate experts, both economists and scientists, and concludes that their consensus estimate, for the SCC today, is about \$200 for the entire sample, or \$80 for the subset who expressed high confidence in their estimates. Estimates from scientists were, on average, much higher than from economists. In another survey of experts on the economics of climate change, over half of the respondents believed that the SCC should be higher than the IWG estimate, and only 8% of respondents believed it should be less (Howard and Sylvan 2015).

A meta-analysis (van den Bergh and Botzen 2014), exploring risks and uncertainties left out of the standard IAM calculations, concluded that the SCC should be at least \$125, and perhaps much higher. A modification of DICE, incorporating new research showing that temperature increases lead to slower economic growth, implies a SCC more than six times the standard DICE estimate today, and rising rapidly beyond that over the next few decades (Moore and Diaz 2015).

In short, there is an enormous range of SCC estimates, including values far above the IWG estimates, that have appeared in the recent climate economics literature. The IWG itself recognized the inherent uncertainty about the value of the SCC and concluded in 2016 that due to the many sources of uncertainty and important limitations in the IAMs (discussed above), the SCC "estimates are likely conservative." The IWG quotes from the IPCC Fourth Assessment Report's conclusion that the SCC "estimates 'very likely . . . underestimate the damage costs' due to omitted impacts. Since then, the peer-reviewed literature has continued to support this conclusion, as noted in the IPCC Fifth Assessment report." (IWG 2016) There is nothing

²⁴ These numbers are for his scenario constrained to stay under 2.5°C of warming. The higher SCC results from the constraint, not from a different damage function. Results in Nordhaus (2017) were published in 2010 dollars, and have been converted to 2017 dollars by multiplying by 1.122.

²⁵ His published value of \$106 for 2010, in 2000 dollars, was multiplied by 1.427 to convert to 2017 dollars.

approaching a consensus about the SCC – which is another way of saying that the exact damages expected from climate change remain uncertain, but potentially very serious.

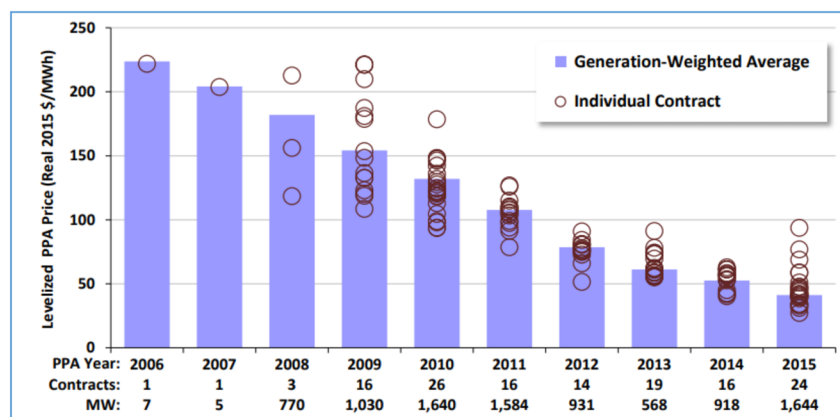
The preceding paragraphs also suggest it would be reasonable to conclude that the actual SCC is several times greater than the Obama Administration’s admittedly conservative and incomplete estimates of the SCC. Those estimates therefore provided a knowingly biased basis for Defendants’ policies and actions favoring the burning of fossil fuels and imposing the costs on these Youth Plaintiffs and future generations. Actions by the Trump Administration to abandon consideration of the SCC deliberately exacerbate the bias.

V. The low cost of climate protection

The costs of climate impacts are high and increasing, while the costs of climate protection technologies are low and decreasing. The uncertainties surrounding climate damages (and hence the benefits of avoiding those damages) involve risks of disastrously worse-than-expected outcomes, which are difficult to rule out with a comfortable level of confidence. In contrast, the uncertainties surrounding the costs of emissions are often a source of optimism: prices for clean energy, especially solar power, have dropped precipitously in recent years.

The leveled prices in purchased power agreements (“PPAs”) for utility-scale photovoltaic installations are falling, as shown in **Figure 1**. These are the prices that independent solar power producers receive when they sign long-term contracts to provide power to local utilities, including the effects of subsidies.²⁶

Figure 1. Levelized photovoltaic PPA prices by contract vintage



Source: Mark Bolinger and Joachim Seel, “Utility-Scale Solar 2015” (Lawrence Berkeley National Laboratory, 2016), p.33.

²⁶ “Levelized” means these are the average present value prices over the lifetime of the contract. They were calculated using a 7% discount rate.

The price of solar electricity generation is falling precipitously. As recently as 2006-07, large-scale solar installations were rare, and the few large-scale solar installations that existed were receiving over \$200 per MWh – or \$0.20 per kwh. By 2014-15, utility-scale contracts were numerous, with average payments of \$50 per MWh (\$0.05 per kwh) or less – that is, less than one-fourth of the rate just eight years earlier. (Other measures of costs of solar power yield different numbers, but the downward trend remains unexpectedly strong, and encouraging.) Ten years ago, it would have seemed foolishly optimistic to predict such a rapid decline in renewable energy costs absent government leadership and support. Yet it has happened: wind and solar power are now important resources in state energy planning. Indeed, wind power plays an even larger role than solar power. In two states, Iowa and South Dakota, wind was the source of more than 30% of total electricity generation in 2016, and 12 other states exceeded 10%.²⁷

There are now multiple studies – based on costs of renewable energy that are only a few years out of date – showing that 80% reduction in emissions by 2050 can be achieved with moderate, if any, increases in energy costs, without assuming any SCC or other internalization of climate damages (Ackerman et al. 2015, Williams, Haley, *et al.* 2015, White House CEQ 2016). This target requires doing more than switching to clean sources of electricity: emissions from electricity generation were only 29% of total U.S. carbon emissions in 2015.²⁸ In addition to introducing nearly emission-free electricity, the 80% reduction target requires electrifying other fossil fuel-using sectors such as light-duty vehicles (cars, pickups, and SUVs), residential and commercial heating, and others.

To achieve the even greater reduction in emissions, close to 100% by 2050, which Hansen et al. (2013) found to be necessary to achieve climate stability, even more must be done. Additional sectors such as heavy-duty vehicles (trucks and buses), agriculture, and industry must also be converted to zero-carbon fuels and technologies. Technologies that reduce emissions in these sectors are also progressing rapidly. For example, through the Department of Energy’s “SuperTruck” program, major truck manufacturers have already produced tractor-trailer prototypes using half the fuel of conventional models.²⁹ This and other advances provide grounds for optimism about completing the transition to a carbon-free economy – a goal that is urgent to complete as rapidly as possible. The urgency with which Defendants treat that goal is ultimately a judgment about how to value today’s youngest generation and those who will follow them.

CONCLUSION AND RECOMMENDATIONS

My expert report identifies deliberate biases in Defendants’ use of the conventional economic treatment of the costs and benefits of climate policies, including the federal government’s development of an estimated social cost of carbon as a measure of expected climate damages. I find that there are multiple reasons why Defendants use of standard economic analyses has materially understated the costs of business as usual, while the costs of taking action to mitigate

²⁷ American Wind Energy Association, “U.S. wind generation reached 5.5% of the grid in 2016”, March 6, 2017, <http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=9999>.

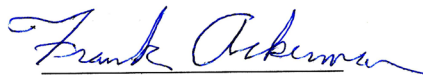
²⁸ Data on emissions from <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>.

²⁹ Department of Energy, “SuperTruck leading the way in efficiency for heavy duty, long haul vehicles”, June 27, 2016, <https://energy.gov/eere/articles/supertruck-leading-way-efficiency-heavy-duty-long-haul-vehicles>.

climate harm have often been exaggerated. As a result, Defendants' economic analyses underestimate and devalue the serious harm from climate change that young people and future generations will experience, allowing the short-term economic benefits of not regulating (or insufficient regulations) to outweigh extremely severe long-term impacts in its cost-benefit analysis. This biased result does not reflect the reality that continuing to burn fossil fuels and increase CO₂ emissions will be extremely harmful to these Youth Plaintiffs and future generations and that this harm far exceeds the costs of implementing measures that would prevent this harm. Accordingly, Defendants have been on notice for some time that their policies pose a substantial risk of serious harm to these Youth Plaintiffs and future generations, and they continue to be deliberately indifferent to that risk.

Defendants are unreasonably placing the welfare of our nation's youngest and future generations at risk, by allowing climate change to proceed with too little effort to reduce emissions and their potentially catastrophic and irreversible impacts. My grandchildren, and the Plaintiffs in this case, as well as the generations that will follow them, deserve a climate and environment as stable and supportive of human and natural life as the one I grew up in. To that end, Defendants should be directed to rapidly accelerate efforts to reduce greenhouse gas emissions, and to stop supporting and promoting fossil fuel energy, supported by the corrected and updated economic analysis that I have described in this expert report.

Signed this 13th day of April, 2018 in Cambridge, Massachusetts.

A handwritten signature in blue ink that reads "Frank Ackerman". The signature is fluid and cursive, with the first name "Frank" and last name "Ackerman" clearly distinguishable.

Frank Ackerman

Exhibit D:

Government Climate and Energy Policies Must
Target <350 ppm Atmospheric CO₂ by 2100 to
Protect Children and Future Generations
(April 2023)



Government Climate & Energy Policies Must Target <350 ppm Atmospheric CO₂ by 2100 to Protect Children & Future Generations

INTRODUCTION

Human laws can adapt to nature's laws, but the laws of nature will not bend for human laws. Government climate and energy policies **must** be based on the best available science to protect our climate system and vital natural resources on which human survival and welfare depend, and to ensure the fundamental rights of young people and future generations are protected.

Because carbon dioxide (CO₂) is the primary driver of Earth energy imbalance (EEI), climate destabilization, and ocean warming and acidification, all government policies regarding CO₂ emissions and CO₂ sequestration should be aimed at reducing global CO₂ concentrations **below 350 parts per million (ppm) by 2100**. Earth's atmospheric CO₂ level, as of 2022, was approximately 419 ppm and rising.¹ With timely action, an emission reductions and sequestration pathway back to <350 ppm could stabilize long-term heating this century at ~1°C above pre-industrial temperatures with further reductions next century.² The temperature of the Earth, much like sea-level rise,³ is a measurable indicator of the CO₂ problem, but it is not a good metric for solving it. EEI and atmospheric CO₂ levels provide measurable standards, with CO₂ emission reductions and sequestration the measurable means to meet those standards.

The current situation highlights the need to reduce carbon dioxide concentrations below 350 ppm, not solely limit future emissions. Emissions must be eliminated in the coming decades. And our carbon sinks must be protected to drawdown more atmospheric CO₂. The world is already too hot to sustain much of the cryosphere. This is akin to taking an ice cube out of the refrigerator. Going above 350 ppm carbon dioxide in the atmosphere was the action that took the ice cube out of the refrigerator; the ice will now inevitably melt. The question then is how warm is our kitchen? Will the ice cube melt in 5 or 20 minutes? But melt it will unless we put the ice cube back in the freezer by reducing carbon dioxide below 350 ppm.

As explained in more detail below, there are numerous scientific bases and lines of evidence supporting setting <350 ppm by 2100 as the uppermost safe limit for atmospheric CO₂ concentrations and global warming. Beyond 2100, atmospheric CO₂ will need to return to well below 350 ppm and closer to the preindustrial level of ~280 ppm to prevent the complete melting of Earth's ice sheets and protect coastal cities from sea-level rise.⁴ Fortunately, it is still not only technically and economically

¹ Ed Dlugokencky & Pieter Tans, NOAA/GML, www.esrl.noaa.gov/gmd/ccgg/trends/.

² In February 2022, the Working Group (WG) II of the Intergovernmental Panel on Climate Change (IPCC) reported that only less than 1.1°C of warming above preindustrial temperatures could be considered a "safe climate" with "dignified living standards for all." IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 79 (2022).

³ Peter U. Clark et al., *Sea-Level Commitment as a Gauge for Climate Policy*, 8 *Nature Climate Change* 653 (2018).

⁴ Peter U. Clark et al., *Consequences of Twenty-First-Century Policy for Multi-Millennial Climate and Sea-Level Change*, 6 *Nature Climate Change* 360 (2016).

feasible to return to <350 ppm by 2100 but also transitioning to clean energy sources will provide significant economic and public health benefits and improve quality-of-life.

WHY GOVERNMENTS MUST AIM FOR <350 PPM AND RESTORING EARTH ENERGY BALANCE

Three lines of robust and conclusive scientific evidence, based on the paleoclimate record and real-world observations, show that above an atmospheric CO₂ concentration of 350 ppm there is: 1) significant EEI; 2) massive ice-sheet destabilization and sea-level rise; and 3) ocean warming and acidification resulting in the bleaching death of coral reefs and other marine life.

1) Earth Energy Imbalance

Scientists say the “Earth energy imbalance (EEI) is the most critical number defining the prospects for continued global warming and climate change,”⁵ which is echoed in the 2021 WGI IPCC 6th assessment report.⁶ “Stabilization of climate, the goal of the universally agreed United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and the Paris Agreement in 2015, requires that EEI be reduced to approximately zero to achieve Earth’s system quasi-equilibrium.”⁷ Earth’s energy flow is significantly out of balance. Because of a buildup of CO₂ (and to a lesser extent other greenhouse gases) in our atmosphere, due to human activities, primarily the burning of fossil fuels and deforestation,⁸ more solar energy is retained in our atmosphere and less energy is released back into space.⁹ (Figure 1.)¹⁰ The measured imbalance from 2010 to 2018 ($0.87 \pm 0.12 \text{ Wm}^{-2}$) was approximately double the imbalance from 1971 to 2018.¹¹

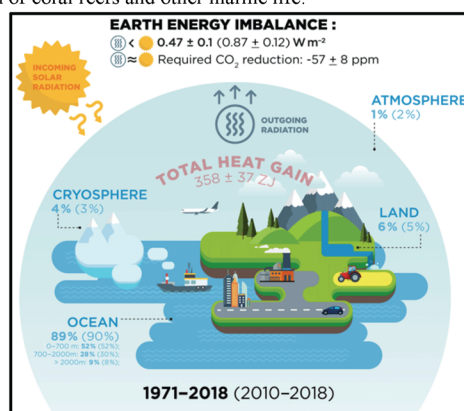


Figure 1: Earth heat inventory for Earth energy imbalance at the top of the atmosphere.

Returning CO₂ concentrations to below 350 ppm would restore the energy balance of Earth by allowing as much heat to escape into space as Earth receives from the Sun, an important historic balance that has kept our planet in the sweet spot for the past 7,000 years, supporting stable sea level

⁵ Karina von Schuckmann et al., *Heat Stored in the Earth System: Where Does the Energy Go?*, 12 Earth Sys. Sci. Data. 2013 (2020) [hereinafter *Heat Stored in the Earth System*] (written by 38 international experts, including lead IPCC authors).

⁶ Piers Forster et al., *The Earth’s Energy Budget, Climate Feedbacks, and Climate Sensitivity*, in *Climate Change 2021: The Physical Science Basis* 14 (2021).

⁷ von Schuckmann, *Heat Stored in the Earth System*.

⁸ IPCC, *Summary for Policymakers*, in *Climate Change 2014: Synthesis Report* (2014).

⁹ James Hansen et al., *Assessing “Dangerous Climate Change”: Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature*, 8 PLOS ONE e81648 (2013) [hereinafter *Assessing “Dangerous Climate Change”*].

¹⁰ von Schuckmann, *Heat Stored in the Earth System*.

¹¹ *Id.*

and coastlines, enabling productive agriculture, and allowing humans and other species to thrive.¹² The paleoclimate record shows that CO₂ levels, temperature, and sea level all move together (Figure 2).¹³ Humans have caused CO₂ levels to rise to levels unprecedented in human existence¹⁴ and the past 3 million years, causing the EEI.¹⁵ The last time atmospheric CO₂ levels were this high, the Hominin “Lucy” (*Australopithecus*) inhabited what is today Ethiopia.¹⁶ The current anthropogenic rate of CO₂ emissions eclipses all prehistoric rates of carbon emissions that nevertheless resulted in global hyperthermal periods and contributed to mass extinctions of 90% of life on the planet and the end of the dinosaurs.¹⁷

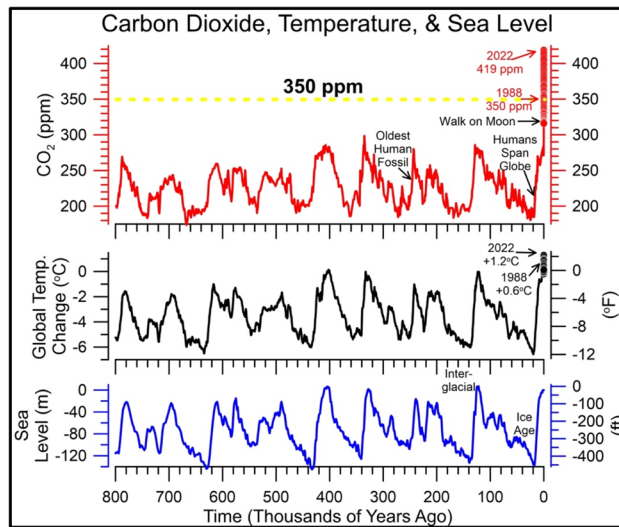


Figure 2: Carbon dioxide, global temperature and sea level for the last 800,000 years.

¹² James Hansen, *Storms of My Grandchildren* 166 (2009).

¹³ Elco J. Rohling et al., *Sea Surface and High Latitude Temperature Sensitivity to Radiative Forcing of Climate over Several Glacial Cycles*, 25 *J. Climate* 1635 (2012); James Hansen et al., *Climate Sensitivity, Sea Level and Atmospheric Carbon Dioxide*, 371 *Philosophical Transactions Royal Society* 21020294 (2013); Elco J. Rohling et al., *Sea Level and Deep-Sea Temperature Reconstructions Suggest Quasi-Stable States and Critical Transitions Over the Past 40 Million Years*, 7 *Science Advances* eabf5326 (2021).

¹⁴ Céline M Vidal et al., *Age of the Oldest Known Homo sapiens from Eastern Africa*, 601 *Nature* 579 (2022).

¹⁵ Gavin L. Foster et al., *Future Climate Forcing Potentially Without Precedent in the Last 420 Million Years*, 8 *Nature Communications* 14845 (2017).

¹⁶ Robert C. Walter, *Age of Lucy and the First Family: Single-Crystal ⁴⁰Ar/³⁹Ar Dating of the Denen Dora and Lower Kada Hadar Members of the Hadar Formation, Ethiopia*, 22 *Geology* 6 (1994).

¹⁷ Sierra V. Petersen et al., *End-Cretaceous Extinction in Antarctica Linked to Both Deccan Volcanism and Meteorite Impact Via Climate Change*, 7 *Nature Communications* 12079 (2016); Philip D. Gingerich, *Temporal Scaling of Carbon Emission and Accumulation Rates: Modern Anthropogenic Emissions Compared to Estimates of PETM Onset Accumulation*, 34 *Paleoceanography Paleoclimatology* 329 (2019); Ying Cui et al., *Massive and Rapid Predominately Volcanic CO₂ Emission During the End-Permian Mass Extinction*, 118 *Proc. Nat'l Acad. Sci.* e201470118 (2021); Jack Longman et al., *Assessing Volcanic Controls in Miocene Climate Change*, 49 *Geophysical Resch. Letters* e2021GL096519 (2022).

2) Ice Sheets, Glaciers and Sea-Level Rise



Figure 3: Antarctic melt water from the Nansen ice shelf.

The last time the ice sheets appeared stable in the modern era was in the 1980s when the atmospheric CO₂ concentration was <350 ppm (Figure 2). The consequences of >350 ppm and >1°C of warming are already visible, significant, and dangerous for humanity. With just over a global average 1°C of warming, glaciers in all regions of the world are shrinking in response to this human-caused climate change, and the rate at which they are melting is accelerating.¹⁸ In fact, >1/3 of the world's glacier mass outside of its ice sheets is predicted to disappear at the current level of global warming.¹⁹ With 1.5°C of warming, the IPCC predicts that "[m]any low elevation and small glaciers around the world will lose their total mass."²⁰ Large parts of the Greenland and Antarctic ice sheets, which required millennia to grow, are teetering on the edge of irreversible disintegration (Figure 3), a point that, if reached, would lock-in major ice-sheet mass loss, sea-level rise of many meters, and worldwide loss of coastal cities – a consequence that would be irreversible on any timescale relevant to humanity.²¹

Greenland ice-sheet melt is currently occurring faster than anytime during the last three and a half centuries, with a 33% increase alone since the 20th century.²² From 1994 to 2017, the Earth lost 28 trillion tonnes of ice; the rate of mass loss from the Greenland and Antarctic ice sheets was seven and four times higher, respectively, for 2010-2016 relative to 1992-1999.²³ The paleoclimate record shows the last time atmospheric CO₂ levels were >400 ppm, the seas were **60 feet higher** than they are today and heating consistent with CO₂ concentrations as low as 400 ppm may have been enough to melt the marine portions of the Antarctica ice sheets.²⁴ Indeed, the current level of global heating may already be sufficient to destabilize the Greenland and West Antarctic ice sheets.²⁵ While many

¹⁸ Jan Oerlemans, *Holocene Glacier Fluctuations: Is the Current Rate of Retreat Exceptional?*, 31 *Annals Glaciology* 39 (2000); Ben Marzeion et al., *Attribution of Global Glacier Mass Loss to Anthropogenic and Natural Causes*, 345 *Science* 919 (2014); Gerard H. Roe et al., *Centennial Glacier Retreat as Categorical Evidence of Regional Climate Change*, 10 *Nature Geoscience* 95 (2017); M. Zemp et al., *Global Glacier Mass Changes and their Contributions to Sea-Level Rise from 1961-2016*, 568 *Nature* 382 (2019); Romain Hugonnet et al., *Accelerated Global Glacier Mass Loss in the Early Twenty-First Century*, 592 *Nature* 726 (2021).

¹⁹ Ben Marzeion et al., *Limited Influence of Climate Change Mitigation on Short-Term Glacier Mass Loss*, 8 *Nature Climate Change* 305 (2018).

²⁰ IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 30 (2022).

²¹ Hansen, *Assessing "Dangerous Climate Change,"* at 13; see also James Hansen et al., *Ice Melt, Sea Level Rise and Superstorms: Evidence from Paleoclimate Data, Climate Modeling, and Modern Observations that 2 °C Global Warming Could be Dangerous*, 16 *Atmos. Chem. & Phys.* 3761 (2016) [hereinafter *Ice Melt, Sea Level Rise and Superstorms*].

²² Luke D. Trusel et al., *Nonlinear Rise in Greenland Runoff in Response to Post-industrial Arctic Warming*, 564 *Nature* 104 (2018).

²³ Thomas Slater et al., *Earth's Ice Imbalance*, 15 *The Cryosphere* 233 (2021); IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 42 (2022).

²⁴ Andrea Dutton et al., *Sea-Level Rise Due to Polar Ice-Sheet Mass Loss During Past Warm Periods*, 349 *Science* aaa4019 (2015); Oana A. Dumitru et al., *Constraints on Global Mean Sea Level During Pliocene Warmth*, 574 *Nature* 233 (2019).

²⁵ Ian Joughin et al., *Marine Ice Sheet Collapse Potentially Under Way for the Thwaites Glacier Basin, West Antarctica*,

experts are predicting multi-meter sea-level rise this century²⁶, even NOAA's modest estimate of 2.0-7.2 feet (0.6-2.2 m) global mean rise by 2100²⁷ would impact millions of Americans (Figure 4).²⁸

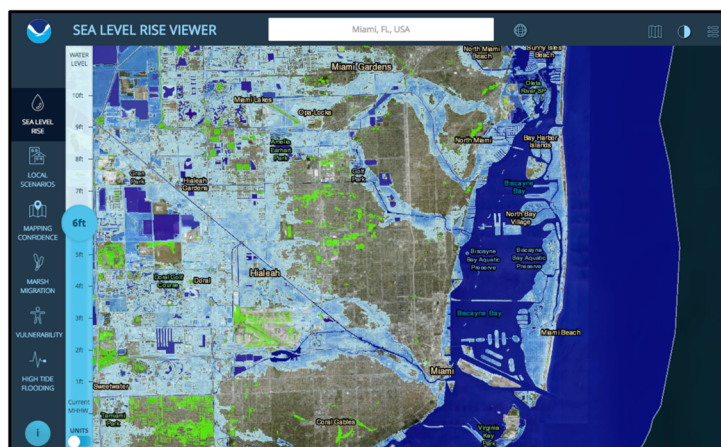


Figure 4: South Florida, including Miami, will face significant inundation with 6 feet of sea-level rise.

The geologic record shows that terrestrial ice sheets retreat and raise sea level at a more linear rate, while marine portions of ice sheets can collapse, rapidly raising sea level in pulses.²⁹ Scientists believe we still have a chance to preserve the large Greenland and Antarctic ice sheets and most of our shorelines and ecosystems if we restore Earth's energy balance and return to below 350 ppm, thereby limiting longer-term warming by the end of the century to no more than 1°C above pre-industrial levels (short-term warming will inevitably exceed 1°C but must not exceed 1°C for more than a short span of years rather than multiple decades or centuries).

344 Science 735 (2014); Alberto V. Reyes et al., *South Greenland Ice-Sheet Collapse During Marine Isotope Stage 11*, 510 Nature 525 (2014); Anders E. Carlson et al., *Earliest Holocene South Greenland Ice-Sheet Retreat Within Its Late-Holocene Extent*, 41 Geophysical Research Letters 5514 (2014); Nicholas R. Golledge et al., *Retreat of the Antarctic Ice Sheet During the Last Interglaciation and Implications for Future Change*, 48 Geophysical Research Letters e2021GL094513 (2021).

²⁶ Jonathan L. Bamber et al., *Ice Sheet Contributions to Future Sea-Level Rise from Structured Expert Judgement*, 116 Proc. Nat'l Acad. Sci. 11195 (2019); Benjamin P. Horton et al., *Estimating Global Mean Sea-Level Rise and Its Uncertainties by 2100 and 2300 from an Expert Survey*, 3 npj Climate Atmospheric Sci. 10.1038/s41612-020-0121-5 (2020).

²⁷ William V. Sweet et al., *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*, NOAA Technical Report NOS 01, xiii (2022).

²⁸ NOAA, *Examining Sea Level Rise Exposure for Future Populations*, <https://coast.noaa.gov/digitalcoast/stories/population-risk.html>.

²⁹ H.R. Wanless, et al., *Dynamics and Historical Evolution of the Mangrove/Marsh Fringe Belt of Southwest Florida, in Response to Sea-level History, Biogenic Processes, Storm Influences and Climatic Fluctuations*, Semi-annual Research Report (June 1993 to February 1994); Hansen, *Ice Melt, Sea Level Rise and Superstorms*, at 3761; Hansen, *Assessing "Dangerous Climate Change,"* at 20; Anders E. Carlson & Peter U. Clark, *Ice Sheet Sources of Sea Level Rise and Freshwater Discharge During the Last Deglaciation*, 50 Reviews Geophysics RG00371; Anders E. Carlson & Kelsey Winsor, *Northern Hemisphere Ice-Sheet Responses to Past Climate Warming*, 5 Nature Geoscience 607 (2012); Jo Brendryen et al., *Eurasian Ice Sheet Collapse Was a Major Source of Meltwater Pulse 1A 14,600 years ago*, 13 Nature Geoscience 363 (2020).

The recent WGII IPCC report noted that ice-sheet disintegration risk increases from “moderate” to “high” risk with warming from the current 1.1°C to 1.5°C and above.³⁰ Indeed, the IPCC WGI 6th assessment report identified the tipping point for Greenland ice-sheet loss to be as low as 1.0°C of warming above the pre-industrial period,³¹ in line with the above referenced evidence for its instability at current levels of global warming and further highlighting the need to reduce global temperature below 1.0°C as soon as possible, as opposed to pursuing policies that target 1.5°C of warming.

3) Ocean Warming and Acidification

Less than 350 ppm is the best scientific standard to protect oceans and marine life. Our oceans have absorbed about 90% of the excess heat in the atmosphere trapped by greenhouse gases (Figure 5) as well as approximately 30% of CO₂ emitted into the atmosphere, causing ocean temperatures to surge and the ocean to become more acidic.³² Indeed, our oceans are warming much more rapidly than previously-thought.³³ In 2020, the oceans absorbed 20 sextillion joules of heat due to climate change and warmed to record levels. The

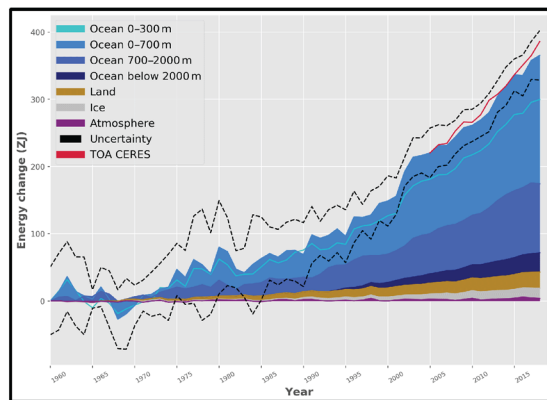


Figure 5. Earth energy accumulation relative to 1960.

quantity of warming, 20,000,000,000,000,000,000,000,000 joules, is equivalent to the amount of energy from 10 Hiroshima atomic bombs being released every second of the year or to heat 1.3 billion kettles of water.³⁴ Many marine ecosystems, and particularly coral reef ecosystems, cannot tolerate the increased warming and acidity of ocean waters that result from increased CO₂ levels.³⁵ At today's global atmospheric CO₂ concentration, ~419 ppm, critically important ocean ecosystems, such as coral reefs, are rapidly declining and will be irreversibly damaged from high ocean temperatures and repeated mass bleaching events if we do not quickly curtail emissions and then achieve negative emissions through sequestration (Figures 6 and 7).³⁶

³⁰ IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 42 (2022).

³¹ Baylor Fox-Kemper et al., *Ocean, Cryosphere and Sea Level Change*, in *Climate Change 2021: The Physical Science Basis* 61 (2021).

³² von Schuckmann, *Heat Stored in the Earth System*; Hansen, *Assessing "Dangerous Climate Change,"* at 1; IPCC, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2013); Lijing Cheng et al., *How Fast are the Oceans Warming?*, 363 *Science* 128 (2019) (as of 2019, about 93% of the energy balance accumulates in the ocean); NOAA, *What is Ocean Acidification?*, <https://oceanservice.noaa.gov/facts/acidification.html>.

³³ Lijing Cheng et al., *How Fast are the Oceans Warming?*, 363 *Science* 128 (2019).

³⁴ <https://www.abc.net.au/news/2021-01-18/ocean-temperatures-reached-record-high-in-2020-study-finds/13062628>; <https://www.cambridgenetwork.co.uk/news/world-continued-warm-2020>.

³⁵ Terry P. Hughes et al., *Global Warming Impairs Stock-Recruitment Dynamics of Corals*, 568 *Nature* 387 (2019).

³⁶ K. Frieler et al., *Limiting Global Warming to 2 °C is Unlikely to Save Most Coral Reefs*, 3 *Nature Climate Change* 165



Figure 6: Healthy coral like this are already gravely threatened and will likely die with warming of 1.5°C.



Figure 7: Bleached coral from warmer ocean temperatures.

According to the IPCC, bleaching events are occurring more frequently than the IPCC previously projected and 70-90% of the world's coral reefs could disappear as soon as 2030 (the IPCC also predicts >99% of coral reefs will die with 2°C warming).³⁷ The 2018 National Climate Assessment acknowledged that coral reefs in Florida, Hawaii, Puerto Rico, and the U.S. Virgin Islands have been harmed by mass bleaching and coral diseases and could disappear by mid-century as a result of warming waters.³⁸ The 2022 IPCC WGII 6th assessment report attributed “warm-water coral bleaching and mortality” to “human-induced climate change”.³⁹ Scientists have concluded we can protect marine life and prevent massive bleaching and die-off of coral reefs only by rapidly returning CO₂ levels to below 350 ppm.⁴⁰

No scientific institution, including the IPCC, has ever concluded that the EEI that exists with >350 ppm CO₂ and 1.5-2.0°C warming would be safe for ocean life. According to Dr. Ove Hoegh-Guldberg, one of the world's leading experts on ocean warming and acidification, and a Coordinating Lead Author on the “The Ocean” chapter of the IPCC's 5th Assessment Report and on the “Impacts

(2013); J.E.N. Veron et al., *The Coral Reef Crisis: The Critical Importance of <350ppm CO₂*, 58 *Marine Pollution Bulletin* 1428 (2009); Terry P. Hughes et al., *Spatial and Temporal Patterns of Mass Bleaching of Corals in the Anthropocene*, 359 *Science* 80 (2018); Terry P. Hughes et al., *Global Warming Impairs Stock-Recruitment Dynamics of Corals*, 568 *Nature* 387 (2019).

³⁷ Ove Hoegh-Guldberg et al., *Impacts of 1.5°C Global Warming on Natural and Human Systems*, in *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, at 225-226 (2018); IPCC, *Summary for Policymakers*, in *Global Warming of 1.5°C* (2018).

³⁸ A.J. Pershing et al., *Oceans and Marine Resources*, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Vol. II (USGCRP, 2018).

³⁹ IPCC, *Summary for Policy Makers*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 8 (2022).

⁴⁰ J.E.N. Veron et al., *The Coral Reef Crisis: The Critical Importance of <350 ppm CO₂*, 58 *Marine Pollution Bulletin* 1428 (2009).

of 1.5°C Global Warming on Natural and Human Systems” of the IPCC’s Special Report on Global Warming of 1.5°C:

“Allowing a temperature rise of up to 2°C would seriously jeopardize ocean life, and the income and livelihoods of those who depend on healthy marine ecosystems. Indeed, the best science available suggests that coral dominated reefs will completely disappear if carbon dioxide concentrations exceed much more than today’s concentrations. Failing to restrict further increases in atmospheric carbon dioxide will eliminate coral reefs as we know them and will deny future generations of children from enjoying these wonderful ecosystems.”⁴¹

IPCC’s Special Report on Global Warming of 1.5° stated that “[w]arming of 1.5°C is not considered ‘safe’ for most nations, communities, ecosystems and sectors and poses significant risks to natural and human systems as compared to the current warming of 1°C (*high confidence*).”⁴² Going further, IPCC WGII stated in their 6th assessment report that “Without urgent and deep emissions reductions, some species and ecosystems, especially those in polar and already-warm areas, face temperatures beyond their historical experience in the next decades (e.g. >20% of species on some tropical landscapes and coastlines at 1.5°C global warming). Unique and threatened ecosystems are expected to be at high risk in the very near term at 1.2°C global warming levels (*very high confidence*) due to... coral reef bleaching...”⁴³ Another recent study found that “warming of 1.5°C relative to pre-industrial levels will be catastrophic for coral reefs.”⁴⁴ With 1.5°C of warming, only 0.2% of the world’s coral reefs would have climate refugia from heating events that drive bleaching (Figure 8).

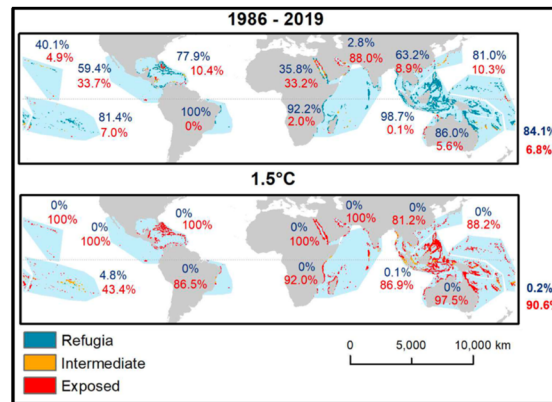


Figure 8: Coral reef refugia (blue symbols and numbers) for 1986-2019 (top) and in a 1.5°C world bottom with exposed reefs indicated by red symbols and numbers.

⁴¹ Ove Hoegh-Guldberg, *Declaration in Support of Petitioners, Foster v. Wash. Dep't of Ecology*, No. 14-2-25295-1 SEA (Wash. Super. Ct. Aug. 24, 2015).

⁴² M.R. Allen et al., *Technical Summary*, in *Global Warming of 1.5°C*, at 44 (2018).

⁴³ IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, 24 (2022).

⁴⁴ Adele M. Dixon et al., *Future Loss of Local-Scale Thermal Refugia in Coral Reef Ecosystems*, 1 PLOS Climate e0000004, 1 (2022).

ADDITIONAL OBSERVATIONS ILLUSTRATE THE DANGERS OF INCREASED WARMING

In addition to the evidence discussed above that illustrates the necessity of ensuring that the atmospheric CO₂ concentration returns to no more than 350 ppm, based on current observations about climate impacts occurring **now**, it is clear that the present level of 419 ppm and attendant 1.2°C of global warming and 260 mm of sea-level rise since the late 1800s⁴⁵ is already causing significant climate impacts; additional warming will exacerbate these already dangerous impacts (Figure 9).

Climate impacts that are already being experienced today include:

- Declining snowpack and rising temperatures are increasing the length and severity of drought conditions, especially in the western United States, causing problems for agriculture, forcing some people to relocate, and leading to water restrictions.⁴⁶
- In addition to causing sea-level rise, glacier retreat adds to the growing water crisis. Glacier loss is impacting reliant ecosystems, including economically important Pacific salmon, and increasing landslide and flood hazards.⁴⁷ In the western United States, glaciers are completely vanishing from mountain ranges, removing a reliable water source in a region already experiencing unprecedented drought.⁴⁸

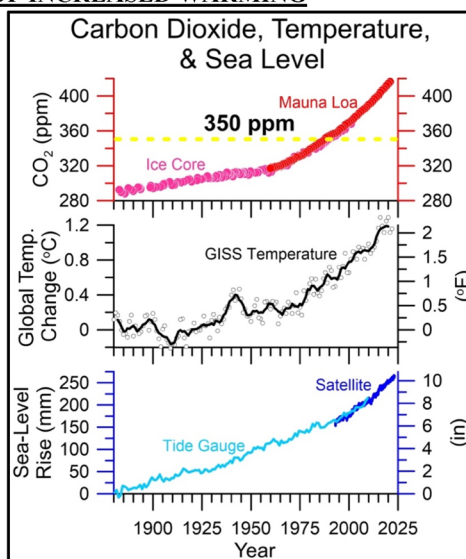


Figure 9: Historical carbon dioxide, global temperature and sea level.

⁴⁵ John A. Church & Neil J. White, *Sea-Level Rise from the Late 19th to the Early 21st Century*, 32 *Survey Geophysics* 585 (2011); <https://data.giss.nasa.gov/gistemp/>; <https://sealevel.colorado.edu>.

⁴⁶ John T. Abatzoglou & A. Park Williams, *Impact of Anthropogenic Climate Change on Wildfire Across Western US Forests*, 113 *Proc. Nat'l Acad. Sci.* 11770 (2016); Philip W. Mote et al., *Dramatic Declines in Snowpack in the Western US*, 1 *npj Climate Atmospheric Science* s41612-018-0012-1 (2018); Steven W. Running, *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-12 (9th Cir. Feb. 7, 2019); Marshall Burke et al., *The Changing Risk and Burden of Wildfire in the United States*, 118 *Proc. Nat'l Acad. Sci.* e2011048118 (2021); A. Park Williams et al., *Rapid Intensification of the Emerging Southwestern North American Megadrought in 2020-2021*, 12 *Nature Climate Change* 232 (2022).

⁴⁷ Matthias Huss et al., *Toward Mountains Without Permanent Snow and Ice*, 5 *Earth's Future* 2016EF000514 (2017); Alexander M. Milner et al., *Glacier Shrinkage Driving Global Changes in Downstream Systems*, 114 *Proc. Nat'l Acad. Sci.* 9770 (2017); Kara J. Pitman et al., *Glacier Retreat and Pacific Salmon*, 70 *Bioscience* 220 (2020); Dan H. Shugar et al., *Rapid Worldwide Growth of Glacial Lakes Since 1990*, 10 *Nature Climate Change* 939 (2020); Jordyn B. Miller et al., *Recharge from Glacial Meltwater is Critical for Alpine Springs and their Microbiomes*, 16 *Env't Rsch. Letters* 064012 (2021).

⁴⁸ J.-B. Bosson et al., *Disappearing World Heritage Glaciers as a Keystone of Nature Conservation in a Changing Climate*, 7 *Earth's Future* 469 (2019); Chelsea J. Martin-Mikle & Daniel B. Fagre, *Glacier Recession Since the Little Ice*

- In the western United States, the wildfire season is now almost three months longer (87 days) than it was in the 1980s.⁴⁹ 10.3 million acres burned in 2020, well above the 2011-2020 average of 7.5 million acres.⁵⁰
- Extreme weather events, such as intense rainfall events that cause flooding, are increasing in frequency and severity because a warmer atmosphere holds more moisture.⁵¹ What are supposedly 1-in-1000-year rainfall events are now occurring with alarming frequency – in 2018 there were at least five such events.⁵² The 2021 U.S. Pacific Northwest heatwave, which broke numerous records, was “virtually impossible” without human-greenhouse gas emissions; at +2.0°C of global warming, such events will occur once to twice a decade.⁵³
- Tropical storms and hurricanes are increasing in frequency and intensity, both in terms of rainfall and windspeed, as warmer oceans provide more energy for the storms (e.g., Hurricanes Harvey, Irma, and Maria in 2017)⁵⁴ (Figure 10).
- Terrestrial ecosystems are experiencing compositional and structural changes, with major adverse consequences for ecosystem services.⁵⁵
- Terrestrial, freshwater, and marine species are experiencing a significant decrease in population size and geographic range, with some going extinct and others are facing the very real prospect of extinction – the rapid rate of extinctions has been called the sixth mass extinction.⁵⁶



Figure 10: Port Arthur, TX flooding August 13, 2018 after Hurricane Harvey.

Age: Implications for Water Storage in a Rocky Mountain Landscape, 51 Arctic, Antarctic, Alpine Resch. 280 (2019); Justin M. Garwood et al., 20th Century Retreat and Recent Drought Accelerated Extinction of Mountain Glaciers and Perennial Snowfields in the Trinity Alps, California, 94 Northwest Sci. 44 (2020); Anders E. Carlson et al., Farewell to Oregon's Central Cascade Glaciers?, 104 Mazama Bulletin 15 (2022).

⁴⁹ Steven W. Running, *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-12 (9th Cir. Feb. 7, 2019); Anthony LeRoy Westerling, *Increasing Western US Forest Wildfire Activity: Sensitivity to Changes in the Timing of Spring*, 371 Phil. Trans. R. Soc. B 20150178 (2016).

⁵⁰ Congressional Research Service, *Wildfire Statistics* (updated Jan. 4, 2021).

⁵¹ Kevin E. Trenberth, *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-3 (9th Cir. Feb. 7, 2019).

⁵² F. Belles, *America's 'One-in-1,000-Year' Rainfall Events in 2018*, The Weather Channel (Sept. 27, 2018).

⁵³ <https://www.worldweatherattribution.org/western-north-american-extreme-heat-virtually-impossible-without-human-caused-climate-change/>.

⁵⁴ Kevin E. Trenberth, *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-3 (9th Cir. Feb. 7, 2019); Kerry Emanuel, *Atlantic Tropical Cyclones Downscaled from Climate Reanalyses Show Increasing Activity over Past 150 Years*, 12 Nature Communications 7027 (2021); Justin T. Maxwell et al., *Recent Increases in Tropical Cyclone Precipitation Extremes over the US East Coast*, 118 Proc. Nat'l Acad. Sci. e2105636118 (2021).

⁵⁵ Connor Nolan et al., *Past and Future Global Transformation of Terrestrial Ecosystems Under Climate Change*, 361 Science 920 (2018).

⁵⁶ Gerardo Ceballos et al., *Accelerated Modern Human-Induced Species Losses: Entering the Sixth Mass Extinction*, 1 Sci. Advances e1400253 (2015); Steven W. Running, *Expert Report, Juliana v. United States*, No. 6:15-cv-01517-TC, Doc. 264-1 (D. Or. June 28, 2018).

- Arctic permafrost thresholds in Canada and Scandinavia may already be surpassed, leading to landscape degradation, infrastructure destruction (Figure 11) and release of greenhouse gases, furthering the climate crisis.⁵⁷ At least 534 settlements will lose their underlying frozen ground and 3.3 million people will be affected (even displaced) from the loss of permafrost that could occur much faster than originally thought due to feedbacks in the Arctic climate system.⁵⁸
- Human health and well-being are already being affected by heat waves, floods, droughts, and extreme events; infectious diseases; and quality of air, food, and water.⁵⁹ Doctors and leading medical institutions are calling climate change a “health emergency.”⁶⁰ Human greenhouse gas emissions have already caused up to 84% of the North American pollen allergy and asthma season lengthening.⁶¹ Children are uniquely vulnerable to climate change health effects due to their higher respiratory rate, lung growth and development, immature immune system, higher metabolic demands, and immature central nervous system.⁶²
- In addition to physical harm, climate change is causing mental health impacts, ranging from stress to clinical disorders such as anxiety, depression, and suicidality, due to exposure to climate events, displacement, loss of income, chronic stress, other impacts of climate change and the belief that their government is not protecting them from climate change.⁶³



Figure 11: House sinking due to permafrost melting near Fairbanks, Alaska.

⁵⁷ Andrew H. MacDougall et al., *Significant Contribution to Climate Warming from the Permafrost Carbon Feedback*, 5 *Nature Geoscience* 719 (2012); April M. Melvin et al., *Climate Change Damages to Alaska Public Infrastructure and the Economics of Proactive Adaptation*, 114 *Proc. Nat'l Acad. Sci.* E122 (2016); Trevor J. Porter et al., *Recent Summer Warming in Northwestern Canada Exceeds the Holocene Thermal Maximum*, 10 *Nature Communications* 1631 (2019); Merritt R. Turetsky et al., *Carbon Release Through Abrupt Permafrost Thaw*, 13 *Nature Geoscience* 138 (2020); Richard E. Fewster et al., *Imminent Loss of Climate Space for Permafrost Peatlands in Europe and Western Siberia*, *Nature Climate Change* s41558-022-01296-7 (2022).

⁵⁸ Justine Ramage et al., *Population Living on Permafrost in the Arctic*, 43 *Population Env't* 22 (2021); Rúnna Magnússon et al., *Extremely Wet Summer Events Enhance Permafrost Thaw for Multiple Years in Siberian Tundra*, 13 *Nature Communications* 1556 (2022).

⁵⁹ K.L. Ebi et al., *Human Health*, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Vol. II (USGCRP, 2018); IPCC, *Summary for Policy Makers*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability* (2022).

⁶⁰ Caren G. Solomon & Regina C. LaRocque, *Climate Change – A Health Emergency*, 380 *N. Engl. J. Med.* 209 (2019).

⁶¹ William R.L. Anderegg et al., *Anthropogenic Climate Change is Worsening North American Pollen Seasons*, 118 *Proc. Nat'l Acad. Sci.* e2013284118 (2021).

⁶² Susan E. Pacheco, *Catastrophic Effects of Climate Change on Children's Health Start before Birth*, 130 *J. Clinical Investigation* 562 (2020); C. May et al., *Northwest*, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Vol. II (USGCRP, 2018); Nick Watts et al., *The 2019 Report of The Lancet Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate*, 394 *The Lancet* 1836 (2019); [Brief of Amici Curiae Public Health Experts, Public Health Organizations, and Doctors in Support of Plaintiffs](#), No. 18-36082, Doc. 47 (9th Cir. Mar. 1, 2019).

⁶³ Lise Van Susteren, [Expert Report, Juliana v. United States](#), No. 6:15-cv-01517-TC, Doc. 271-1 (D. Or. June 28, 2018). K.L. Ebi et al., *Human Health*, in *Impacts, Risks, and Adaptation in the United States: Fourth National Climate*



Figure 12: Offutt Air Force Base was impacted by flood waters during flooding in Nebraska during spring 2019.

• As Congress has recognized, “climate change is a direct threat to the national security of the United States and is impacting stability in areas of the world both where the United States Armed Forces are operating today, and where strategic implications for future conflict exist.”⁶⁴ Senior military leaders have called climate change “the most serious national security threat facing our Nation today,”⁶⁵ a conclusion similarly recognized by our Nation’s intelligence community.⁶⁶ Climate change is increasing food and water

shortages, pandemic disease, conflicts over refugees and resources, and destruction to homes, land, infrastructure, and military assets, directly threatening our military personnel and the “Department of Defense’s ability to defend the Nation” (Figure 12).⁶⁷

- Climate change is already causing vast economic harm in the United States. Since 1980 the United States has experienced 310 climate and weather disasters that each caused damages in excess of \$1 billion, for a total cost of \$2.160 trillion and 15,180 deaths.⁶⁸ In 2021 alone, weather and climate related disasters cost the United States in excess of \$145 billion, which was ranked only third in terms of cost.⁶⁹

These already serious impacts will grow in severity and will impact increasingly large numbers of people and parts of the world if CO₂ concentrations continue to rise, which is what would happen if climate policies are targeted to achieving 1.5°C of warming or net zero emissions, as opposed to negative emissions. If we want our children and grandchildren to have a safe planet to live on, full of health and biodiversity rather than chaos and conflict, we must follow the best scientific prescription to restore Earth’s energy balance and avoid the destruction of our planet’s atmosphere, climate, and oceans.

Assessment, Vol. II (USGCRP, 2018); Caroline Hickman et al., *Climate Anxiety in Children and Young People and Their Beliefs About Government Responses to Climate Change: A Global Survey*, 5 *The Lancet* e863 (2021); IPCC, *Summary for Policy Makers*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability* (2022).

⁶⁴ *National Defense Authorization Act for Fiscal Year 2018*, Pub. L. No. 115-91, 131 Stat. 1358.

⁶⁵ Vice Admiral Lee Gunn, USN (Ret.), *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-17 (9th Cir. Feb. 7, 2019) (emphasis in original); see also CNA Military Advisory Board, *National Security and the Accelerating Risks of Climate Change* (2014).

⁶⁶ National Intelligence Council, *Implications for US National Security of Anticipated Climate Change* (Sept. 2016).

⁶⁷ U.S. Dep’t of Defense, *2014 Climate Change Adaptation Roadmap* (2014).

⁶⁸ NOAA, *Billion Dollar U.S. Weather/Climate Disasters 1980-2021* (2022), <https://www.ncdc.noaa.gov/billions/>.

⁶⁹ <https://www.climate.gov/news-features/blogs/beyond-data/2021-us-billion-dollar-weather-and-climate-disasters-historical>.

**INTERNATIONAL POLITICAL TARGETS OF 1.5°C OR 2.0°C
ARE NOT SCIENCE-BASED AND ARE NOT SAFE**

International treaties require the stabilization of the climate system to avoid dangerous anthropogenic climate change. As described above, EEL and CO₂ concentrations should be the measurable scientific metrics, adopted as legal standards, for setting emission reduction and sequestration targets to stabilize our climate, avoid danger, and protect children and future generations. Temperature targets, set higher than today's already-too-hot planet that would mean even greater and more dangerous EEI and greater instability, are incompatible with fundamental human rights. International, politically-established temperature targets like 1.5°C or "well below" 2.0°C – which are commonly associated with long-term atmospheric CO₂ concentrations of 425 and 450 ppm, respectively and "net zero emissions" – have not been and are not presently considered safe or scientifically-sound targets for present or future generations.

Neither 1.5°C nor 2.0°C warming above pre-industrial levels has ever been considered "safe" from either a political or scientific point of view. The 2.0°C figure was originally adopted in the political arena "from a set of heuristics," and it has retained predominantly political character ever since.⁷⁰ One review of climate economics noted that the 2.0°C figure was actually proposed by policy makers, not scientists.⁷¹ The 2.0°C figure has been all-but-abandoned as a credible policy goal, in light of the findings in IPCC's 1.5°C Special Report, and the mounting evidence leading up to its publication, that 2.0°C would be catastrophic relative to lower, still-achievable levels of warming.⁷²

On the other hand, the idea of a 1.5°C target was first raised by the Alliance of Small Island States (AOSIS) in the negotiations leading up to the ill-fated 2009 UNFCCC Conference of Parties in Copenhagen.⁷³ AOSIS, however, was explicitly advocating a *well below* 1.5°C and *well below* 350 ppm target, on the basis of the research of Dr. James Hansen and his colleagues.⁷⁴ Political compromise, including pressure from the fossil fuel industry, on this target then led to the adoption of a goal of "pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" in Article 2 of the Paris Agreement. Yet the 2018 IPCC Special Report on 1.5°C has made clear that allowing a temperature rise of 1.5°C:

is **not considered 'safe'** for most nations, communities, ecosystems and sectors and poses significant risks to natural and human systems as compared to the current warming of 1°C (*high confidence*).⁷⁵

⁷⁰ Samuel Randalls, *History of the 2°C Climate Target*, 1 WIREs Climate Change 598, 603 (2010); Carlo C. Jaeger & Julia Jaeger, *Three Views of Two Degrees*, 11 (Suppl 1) Reg. Env't Change S15 (2011).

⁷¹ Eva Lövbrand, *Co-Producing European Climate Science and Policy: A Cautionary Note on the Making of Useful Knowledge*, 38 Science Public Policy 225, 233 (2011).

⁷² IPCC, *Summary for Policymakers*, in Climate Change 2014: Impacts, Adaptation, and Vulnerability, 13-14 (2014); UNFCCC, *Report on the Structured Expert Dialogue on the 2013-2015 Review*, 18 (2015), <http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf>; Petra Tschakert, *1.5°C or 2°C: A Conduit's View from the Science-Policy Interface at COP20 in Lima, Peru*, 2 Climate Change Responses 8 (2015); IPCC, *Global Warming of 1.5°C* (2018).

⁷³ See Robin Webster, *A Brief History of the 1.5°C Target*, Climate Change News (Dec. 10, 2015), <http://www.climatechangenews.com/2015/12/10/a-brief-history-of-the-1-5c-target/>.

⁷⁴ *Submission from Grenada on behalf of AOSIS to the Ad Hoc Working Group on Further Commitments for Annex I Parties Under the Kyoto Protocol*, U.N. Doc. FCCC/KP/AWG/2009/MISC.1/Add.1 (25 March 2009), <https://unfccc.int/sites/default/files/resource/docs/2009/awg7/eng/misc01a01.pdf>, citing James Hansen et al. *Target Atmospheric CO₂: Where Should Humanity Aim?* 2 The Open Atmospheric Science Journal 217 (2008).

⁷⁵ M.R. Allen et al., *Technical Summary*, in Global Warming of 1.5°C, at 44 (2018) (emphasis added).

Creating climate policies that allow heating of 1.5°C-2.0°C legalizes and locks in greater dangers than we have already witnessed. It is a death sentence for young people. In fact, Sir David King, former Special Envoy for Climate Change and Chief Scientific Advisor for the United Kingdom, elaborated on the importance of 350 ppm and limiting global heating to 1.0°C:

“As a key negotiator for the United Kingdom government during discussions leading up to the Paris Agreement, I advocated that 1.5°C was an acceptable level of global warming. However, I was wrong. In 2020, our planet experienced an average of 1.1°C of warming — much higher in some places like the Arctic — and we experienced catastrophic weather events and climate-related disasters. These will only become more frequent, and more severe, as our emissions continue to rise. We cannot afford to negotiate what we now know is the safest level for stabilizing our climate systems: We must limit warming to less than 1.0°C as fast as possible. The 350 ppm pathways findings in studies by Jim Williams and Evolved Energy Research successfully demonstrate that the United States has clear pathways available to significantly reduce emissions, protecting the health and livelihood of their citizens while also boosting their national economies. This will crucially enable the USA to join leading nations in managing this severe challenge to humanity.”⁷⁶

Sir David King also stated:

“We need to get ourselves back down to 350 parts per million or less carbon dioxide equivalent.”⁷⁷

Importantly, the IPCC has never established nor endorsed a target of 1.5°C or 2.0°C warming as a limit below which the climate system will be stable, and the energy balance restored. It is beyond the IPCC’s declared mandate to endorse a particular threshold of warming as “safe” or “dangerous.” As the IPCC makes clear, “each major IPCC assessment has examined the impacts of [a] multiplicity of temperature changes but has left [it to the] political processes to make decisions on which thresholds may be appropriate.”⁷⁸ Unfortunately, one flaw in the IPCC’s work is that it has always looked at pathways to higher levels of planetary heating, not lower levels, and it has not focused its analysis on restoring Earth’s Energy Imbalance. Nonetheless, the IPCC has evaluated and published the extensive harms of even 1°C of heating on children and the planet.

The 2022 IPCC WGII 6th assessment report found that: “In terrestrial ecosystems, 3 to 14% of species assessed will *likely* face very high risk of extinction at global warming levels of 1.5°C” and “[i]n ocean and coastal ecosystems, risk of biodiversity loss ranges between moderate and very high by 1.5°C global warming level”⁷⁹ They also stated: “Projections suggest that 350 million (± 158.8 million) more people in urban areas will be exposed to water scarcity from severe droughts at 1.5°C warming”⁸⁰ Similarly, “[a]daptation to address risks of heat stress, heat mortality and reduced capacities for outdoor work for humans, face soft and hard limits across regions become significantly

⁷⁶ Correspondence from Sir David King to Julia Olson (Jan. 2021) (notes on file with Julia Olson); The Do One Better! Podcast, Interview with Sir David King, <https://www.lidji.org/sir-david-king>.

⁷⁷ <https://www.lidji.org/sir-david-king>.

⁷⁸ IPCC, *Climate Change 2014: Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report* 125 (Cambridge University Press, 2014).

⁷⁹ IPCC, *Summary for Policy Makers*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability* 15-6 (2022).

⁸⁰ IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability* 37 (2022).

more severe at 1.5°C...⁸¹ Such extinction, ecosystem losses, thirst, droughts, stress and death fly in the face of any claim that 1.5°C of global warming is somehow “safe”.

Dr. James Hansen warns that “distinctions between pathways aimed at ~1°C and 2°C warming are much greater and more fundamental than the numbers 1°C and 2°C themselves might suggest. These fundamental distinctions make scenarios with 2°C or more global warming far more dangerous; so dangerous, we [James Hansen et al.] suggest, that aiming for the 2°C pathway would be foolhardy.”⁸² This target is at best the equivalent of “flip[ping] a coin in the hopes that future generations are not left with few choices beyond mere survival. This is not risk management, it is recklessness and we must do better.”⁸³

Tellingly, more than 80 eminent scientists from over 50 different institutions have been co-authors on publications in peer-reviewed journals finding that the maximum level of atmospheric CO₂ consistent with restoring the EEI, protecting humanity and other species is 350 ppm, and no one, including the IPCC, has published any scientific evidence to counter that 350 ppm is the maximum safe concentration of CO₂.⁸⁴

A 1.5°C OR 2.0°C TARGET RISKS LOCKING-IN DANGEROUS FEEDBACKS

The longer the length of time atmospheric CO₂ concentrations remain at dangerous levels (i.e., above 350 ppm) and there is an EEI, the risk of triggering, and locking-in, dangerous warming-driven feedback loops increases. The 1.5°C or 2.0°C target (linked to 425-450 ppm) reduces the likelihood that the biosphere will be able to sequester CO₂ due to carbon cycle feedbacks and shifting climate zones.⁸⁵ As Earth surface temperatures increase, forests burn and soils warm, releasing their carbon. These natural carbon “sinks” become carbon “sources” and a portion of the natural carbon sequestration necessary to drawdown excess CO₂ simply disappear. Another dangerous feedback includes the release of methane (along with CO₂), a potent greenhouse gas, as the global permafrost thaws.⁸⁶ These feedbacks might show little change in the short-term (with the exception of permafrost melting, which may already be triggered in parts of the Arctic⁸⁷), but can hit a point of no return, even

⁸¹ IPCC, *Technical Summary*, in *Climate Change 2022: Impacts, Adaptation and Vulnerability* 57 (2022).

⁸² Hansen, *Assessing “Dangerous Climate Change,”* at 15.

⁸³ Matt Vespa, *Why 350? Climate Policy Must Aim to Stabilize Greenhouse Gases at the Level Necessary to Minimize the Risk of Catastrophic Outcomes*, 36 *Ecology Law Currents* 185, 186 (2009).

⁸⁴ James Hansen, et al., *Target Atmospheric CO₂: Where Should Humanity Aim?* 2 *The Open Atmospheric Science Journal* 217 (2008); Hansen, *Assessing “Dangerous Climate Change”*; Hansen, *Ice Melt, Sea Level Rise and Superstorms*; James Hansen, et al., *Young People’s Burden: Requirement of Negative CO₂ Emissions*, 8 *Earth Syst. Dynamics* 577 (2017); J.E.N. Veron, et al., *The Coral Reef Crisis: The Critical Importance of <350 ppm CO₂* 58 *Marine Pollution Bulletin* 1428 (2009); K. Frieler, et al., *Limiting Global Warming to 2 °C is Unlikely to Save Most Coral Reefs* 3 *Nature Climate Change* 165 (2013); von Schuckmann, *Heat Stored in the Earth System*; Communication from James Hansen, Karina von Shuckmann to Julia Olson (2021) (notes on file with Julia Olson).

⁸⁵ Hansen, *Assessing “Dangerous Climate Change,”* at 15, 20.

⁸⁶ *Id.*; Andrew H. MacDougall et al., *Significant Contribution to Climate Warming from the Permafrost Carbon Feedback*, 5 *Nature Geoscience* 719 (2012); Gustaf Hugelius et al., *Large Stocks of Peatland Carbon and Nitrogen are Vulnerable to Permafrost Thaw*, 117 *Proc. Nat’l Acad. Sci.* 20438 (2020).

⁸⁷ Trevor J. Porter et al., *Recent Summer Warming in Northwestern Canada Exceeds the Holocene Thermal Maximum*, 10 *Nature Communications* 1631 (2019); Richard E. Fewster et al., *Imminent Loss of Climate Space for Permafrost*

at a 1.5°C or 2.0°C temperature increase, which will trigger accelerated heating and sudden *and irreversible* catastrophic impacts. Moreover, an emission reduction target aimed at 2.0°C would “yield a larger eventual warming because of slow feedbacks, probably at least 3°C.”⁸⁸ Once global warming of 2.0°C is reached, there will already be “additional climate change ‘in the pipeline’ even without further change of atmospheric composition.”⁸⁹ This is evidenced by committed ice-sheet retreat and attendant sea-level rise. At our current 1.2°C of warming, the committed rise in sea level is at least 30 feet (9 m) over the coming centuries and millennia; at 1.5°C, more than 45 feet (14 m) of sea-level rise is committed that increases to greater than 70 feet (21 m) at 2.0°C.⁹⁰ In short, even at our current level of global warming, the seas will not stop rising for thousands of years; additional warming will only increase the rate and amount that the seas rise. Because the IPCC projects Earth reaching 1.5°C of global warming by 2035,⁹¹ the time to stop greenhouse gas emissions and reduce already to high atmospheric CO₂ concentration is now.

THE BEST AVAILABLE SCIENCE REQUIRES US TO REDUCE CO₂ LEVELS TO <350 PPM BY 2100

There are two steps to reducing CO₂ levels to <350 ppm by the end of the century: 1) reducing CO₂ emissions to near zero by 2050; and separately 2) sequestering excess CO₂ already in the atmosphere, which can be accomplished primarily by protecting and enhancing our natural carbon sinks (carbon drawdown). Politically-motivated emission reduction targets that seek to reduce CO₂ emissions by only 80% by 2050 are consistent with an atmospheric CO₂ concentration of 450 ppm and long-term warming of 2.0°C, which, as described above, would result in catastrophic and irreversible impacts for the climate system and oceans and an eventual Earth temperature of >3.0°C.

The politically popular concept of “net zero,” associated with achieving 1.5°C of warming, allows governments to zero out a percentage of ongoing fossil fuel emissions by counting them as “sequestered” through removal processes, such as biogenic or natural sequestration in carbon sinks, leaving a smaller amount of source “net emissions” to be reduced.⁹² However, in order to align emissions and sequestration with a <350 ppm standard, carbon removed through natural sequestration in sinks must be used to draw down the excess CO₂ already in the atmosphere from cumulative historic emissions, not to provide a negative credit or offset for ongoing emissions. Emissions and sequestration must be accounted and inventoried separately with separate standards for each category.⁹³ A “net zero” emissions target is a shell game with little accountability,⁹⁴ detached from a precise standard for protection of fundamental rights and restoration of Earth’s energy balance.

Peatlands in Europe and Western Siberia, Nature Climate Change s41558-022-01296-7 (2022); Charles K. Paull et al., *Rapid Seafloor Changes Associated with the Degradation of Arctic Submarine Permafrost*, 119 Proceedings Nat’l Academy Sciences e2119105119 (2022).

⁸⁸ Hansen, *Assessing “Dangerous Climate Change,”* at 15.

⁸⁹ *Id.* at 19.

⁹⁰ Peter U. Clark et al., *Consequences of Twenty-First-Century Policy for Multi-Millennial Climate and Sea-Level Change*, 6 Nature Climate Change 360 (2016); Peter U. Clark et al., *Sea-Level Commitment as a Gauge for Climate Policy*, 8 Nature Climate Change 653 (2018).

⁹¹ IPCC, *Technical Summary*, in Climate Change 2022: Impacts, Adaptation and Vulnerability, 8 (2022).

⁹² Sam Fankhauser et al., *The Meaning of Net Zero and How to Get It Right*, 12 Nature Climate Change 15 (2022).

⁹³ Duncan P. McLaren et al., *Beyond “Net-Zero”: A Case for Separate Targets for Emissions Reduction and Negative Emissions*, *Frontiers in Climate* (2019).

⁹⁴ Sam Fankhauser et al., *The Meaning of Net Zero and How to Get It Right*, 12 Nature Climate Change 15, 17 (2022).

**IT IS TECHNOLOGICALLY AND ECONOMICALLY FEASIBLE
TO REDUCE EMISSIONS IN LINE WITH 350 PPM BY 2100**

Importantly, it is economically and technologically feasible to transition the entire U.S. energy system to a zero-CO₂ energy system by 2050 and to drawdown the excess CO₂ in the atmosphere through reforestation and carbon sequestration in soils and other geological reservoirs.⁹⁵

Deep Decarbonization Pathways Project and Evolved Energy Research recently completed research and very sophisticated modeling describing a near complete phase out of fossil fuels in the U.S. by 2050.⁹⁶ They describe six different technologically feasible pathways to drastically, and quickly, cut our reliance on fossil fuels and achieve the requisite level of emissions reductions in the U.S. while meeting our nation's forecasted energy needs. All of the 350 ppm pathways rely on four pillars of action: a) investment in energy efficiency; b) electrification of everything that can be electrified; c) shifting to very low-carbon and primarily renewable electricity generation; and d) CO₂ capture as fossil fuels are phased out. The six scenarios are used to evaluate the ability to meet the targets even absent one key technology. For example, one scenario describes a route to 350 ppm absent construction of new nuclear facilities; another illustrates achieving 350 ppm with extremely limited biomass technology; still another describes a means to 350 ppm without any carbon capture and storage. Even absent a key technology, each of these six routes are viable and cost effective.

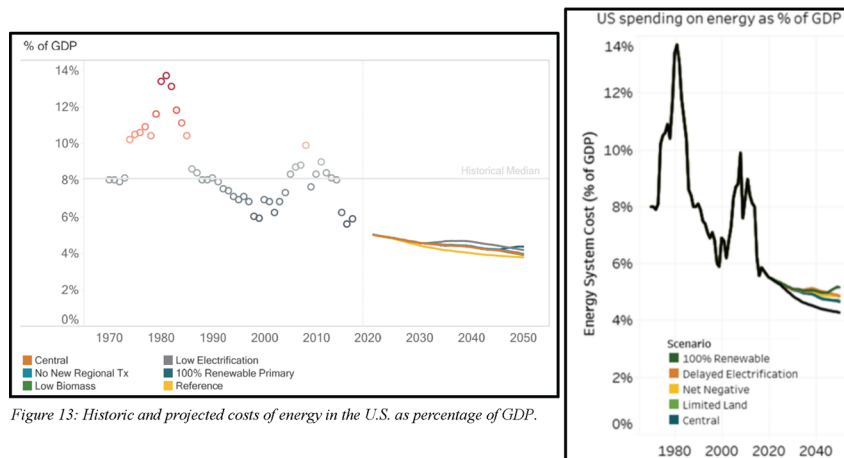


Figure 13: Historic and projected costs of energy in the U.S. as percentage of GDP.

⁹⁵ See Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States*, 8 Energy & Env't Sci. 2093 (2015) (for plans on how the United States and over 100 other countries can transition to a 100% renewable energy economy see www.thesolutionsproject.org); see also Arjun Makhijani, *Carbon-Free, Nuclear-Free: A Roadmap for U.S. Energy Policy* (2007); B. Haley et al., Evolved Energy Research, *350 PPM Pathways for the United States* (2019); James Williams et al., *Carbon-Neutral Pathways for the United States*, 2 AGU Advances e2020AV000284 (2021).

⁹⁶ B. Haley et al., Evolved Energy Research, *350 PPM Pathways for the United States* (2019).

A related 2021 study concludes that emissions reductions consistent with a 350 ppm trajectory by 2100 can be done at low net cost, substantially lower than estimates for less ambitious 80% by 2050 scenarios a few years ago due to recent declines in solar, wind, and vehicle battery prices.⁹⁷ The cost would be well below the 9.5% of GDP spent on the energy system in 2009 (not to mention well below the harm to the economy caused by climate change). (Figure 13)⁹⁸ Once the transition is complete, the cost of energy will remain low and stable because we will no longer be dependent on volatile global fossil fuel markets for our energy supplies. As Nobel Laureate Economist Dr. Joseph Stiglitz has stated: “[t]he benefits of making choices today that limit the economic costs of climate change far outweigh any economic costs associated with limiting our use of fossil fuels.”⁹⁹

Other experts have already prepared plans for all 50 U.S. states as well as for over 139 countries that demonstrate the technological and economic feasibility of transitioning off fossil fuels toward 100% of energy, for all energy sectors, from clean and renewable energy sources: wind, water, and sunlight by 2050 (with 80% reductions in fossil fuels by 2030).¹⁰⁰

Products already exist that enable new construction or retrofits that result in zero greenhouse gas buildings. We have the technology to meet all electricity needs with zero-emission electric generation. We know how to achieve zero-emission transportation, including aviation. These actions result in other benefits, such as improved health, job creation, and savings on energy costs.

The amount of natural carbon sequestration required is also proven to be feasible. Researchers have evaluated the potential to drawdown excess carbon dioxide in the atmosphere by increasing the carbon stored in forests, soils, and wetlands, and have found significant potential for these natural systems to support a return to 350 ppm by the end of the century.¹⁰¹ We know the agricultural, rangeland, wetland, and forest management practices that decrease greenhouse gas emissions and increase sequestration.

There is no scientific, technological, or economic reason to *not* adopt a target of <350 ppm atmospheric CO₂ and 1.0°C by 2100. There are abundant reasons for doing so, not the least of which is to do our best through human laws to respect the laws of nature and create a safe and healthy world for children and future generations.

⁹⁷ James Williams et al., *Carbon-Neutral Pathways for the United States*, 2 AGU Advances e2020AV000284 (2021).

⁹⁸ *Id.*, Ben Haley et al., Evolved Energy Research, *350 PPM Pathways for Florida, Technical Supplement* (2020).

⁹⁹ Joseph E. Stiglitz, Ph.D., *Declaration in Support of Plaintiffs, Juliana v. United States*, No. 18-36082, Doc. 21-14 (9th Cir. Feb. 7, 2019).

¹⁰⁰ Mark Z. Jacobson et al., *100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States*, 8 Energy & Env’t Sci. 2093 (2015); Mark Z. Jacobson et al., *Zero Air Pollution and Zero Carbon from all Energy at Low Cost and Without Blackouts in Variable Weather Throughout the U.S. with 100% Wind-Water-Solar and Storage*, 184 Renewable Energy 430 (2022). For a graphic depicting the overview of the plan for the United States see: <https://thesolutionsproject.org/why-clean-energy/#/map/countries/location/USA>.

¹⁰¹ Benson W. Griscom et al., *Natural Climate Solutions*, 114 Proc. Nat’l Acad. Sci. 11645 (2017); Joseph E. Fargione et al., *Natural Climate Solutions for the United States*, 4 Science Advances eaat1869 (2018); C. Ronnie Drever et al., *Natural Climate Solutions for Canada*, 7 Sci. Advances eabd6034 (2021).

