ROOSEVELT INSTITUTE
REIMAGINE THE RULES

Decarbonizing the US Economy

Pathways Toward a Green New Deal

A Roosevelt Institute report written by Mark Paul, Anders Fremstad, and J.W. Mason

June 2019

About the Authors

Mark Paul

Mark Paul is a fellow at the Roosevelt Institute, where he works on the 21st Century Economy project, and an assistant professor of economics at New College of Florida. His current research focuses on understanding the causes and consequences of inequality and assessing and designing remedies to address it.

Anders Fremstad

Anders Fremstad is an assistant professor of economics at Colorado State University (CSU) and a resident fellow at CSU's School of Global Environmental Sustainability. His research focuses on the intersection between environmental economics and political economy, and he also studies the sharing economy.

J.W. Mason

J.W. Mason is a fellow at the Roosevelt Institute and an assistant professor of economics at John Jay College, CUNY. His research focuses on the history and political economy of credit, including the evolution of household debt and the changing role of financial markets in business investment.

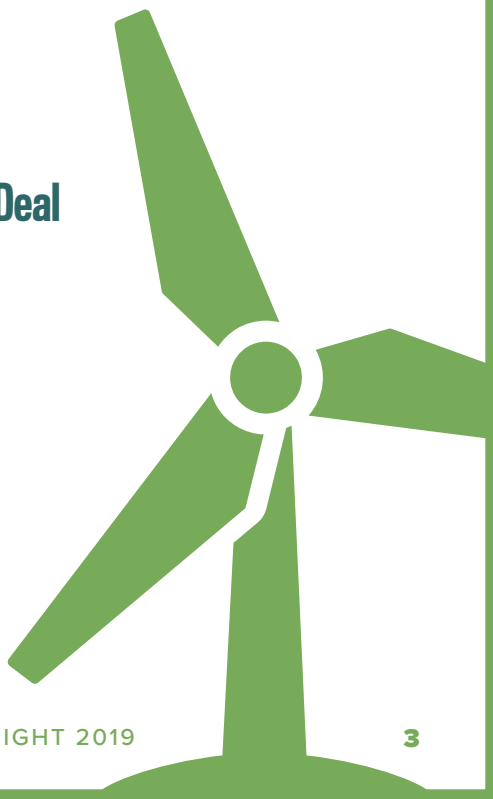
*With key contributions made by **Susan R. Holmberg**.*

Acknowledgments

The authors thank James K. Boyce, Ben Beachy, Kate Brandt, Dan Lashof, Ben Lilliston, Collin Rees, and Carla Santos Skandier for their comments and insight. Special thanks for research assistance from Kristina Karlsson, Zane Mokhiber, and Connor Rupp. Roosevelt staff Nell Abernathy, Kendra Bozarth, Matt Hughes, Mike Konczal, and Felicia Wong all contributed to the project.

This report was made possible with the generous support of Partners for a New Economy. The contents of this publication are solely the responsibility of the authors.

Table of Contents



Executive Summary

The great problem of the 21st century is climate change. It is a problem not for the future but for today: The global community must achieve carbon neutrality by 2050 to avoid the most catastrophic consequences of a warming world. Action on this issue in the US, however, has been stunted by a lack of political will: For half of a century, American politics and policymaking have been guided by a set of economic assumptions that effectively rule out vigorous action by the public sector in response to problems such as climate change. Economists and policymakers have assumed that addressing the climate crisis must involve further sacrifices by those already falling behind—that the only way to reduce carbon emissions is through policies that would drastically lower living standards and economic growth. If taxes and regulation are effective at lowering carbon emissions, in this view, it is only at the cost of reducing the economy's ability to meet other vital needs. A massive expansion of government spending in response to climate change, says this consensus view, is simply unaffordable; if seriously attempted, it would bankrupt the country. So climate change has remained, in our political discourse, one problem among others: Small, low-cost steps are taken, but a more comprehensive solution is dismissed as not worth the cost.

In this report, we argue that this framing is wrong. We do not need to choose between a robust response to climate change and meeting people's material needs today. Contrary to orthodox theory, the US economy is not operating at its maximum productive potential; there is a great deal of unused capacity that a major public investment program could mobilize. And contrary to the policy orthodoxy, climate change requires such a public program—not a market-based approach of taxes and subsidies. Under a public-investment-led program like we propose here, a rapid move to a carbon-neutral economy would not imply a fall in living standards for working Americans. On the contrary, in an economy facing persistent demand constraints and weak labor markets, public spending on decarbonization will raise wages and living standards.

The mobilization around a Green New Deal is one of the most exciting developments in US politics in many years. It has created space to move beyond the narrow discussions of environmental policy of the past generation, and to instead discuss a massive mobilization of our collective resources that would benefit the planet, the economy, and everyday people's lives.

This report provides a policy framework and sample policies to decarbonize the economy. While we believe that the policies described here are essential, they are not comprehensive. We offer them as a starting point for a broader discussion, as pathways toward a more comprehensive Green New Deal. We believe that decarbonization can be done in an equitable, rapid, and pro-growth way if we deploy a three-pillar approach—one that uses the *entire* range of policy tools available to us: 1) large-scale public investments; 2) comprehensive regulations to ensure decarbonization across the board; and 3) a cap-and-dividend system that puts a price on carbon while offsetting the regressive effects on income distribution. These tools can be leveraged to rapidly phase out existing fossil fuels and to build the carbon-neutral economy we need. This report describes policies that hinge on the government's unique ability to meet the scale and urgency of this crisis through public investment, provisioning, and regulation.

Current macroeconomic conditions are such that spending on public investment should be considered a benefit, not a cost.

It is within our power to collectively reshape our economy to continue meeting our material needs while preserving a habitable planet. Even if a decarbonization package requires 5 percent of GDP per year over a decade-plus time period, expanded public spending can be safely financed through increased public debt, supplemented with some tax increases—which are desirable for their own sake. Current macroeconomic conditions are such that spending on public investment should be considered a benefit, not a cost. More public spending will help the economy run hotter, resulting in tight labor markets and sustained wage growth—growth that has long been elusive.

Transitioning away from fossil fuels will preserve a habitable planet for our grandchildren, but rapid decarbonization will also fundamentally reshape our economy. This presents an opportunity to transform our economy in ways that will raise income and economic security for the great majority, as well as improving our lives in other less quantifiable ways. A Green New Deal can build on the existing roles and capabilities of government to reshape the economy in a conscious, deliberate way in the interests of a habitable planet and of an economy that supports human flourishing.

Proposals for addressing climate change are a key part of the current political debate. This report complements those proposals by providing an economic case for rapidly decarbonizing the economy through a public-investment-led approach.

Introduction

The climate crisis is not a problem for future generations; it is happening now, and it requires immediate action. Sea levels are rising. Storms and droughts are becoming more severe. Climate change is already contributing to displacement, refugee crises, and political instability.[1] While the effects in the United States and other rich countries are, so far, less catastrophic than in much of Africa, Latin America, and South Asia, they are present and certain to grow worse. The policy tools we have deployed for the last 50 years are incapable of tackling these challenges. It is past time to mobilize all of society's resources and capabilities to address this crisis.

For too long, we have failed to act on these challenges or met them with minor tweaks that fall short of the scale necessary to address climate change. American politics and policymaking have been guided by a mistaken vision of economic scarcity, which held that addressing the climate crisis must involve further sacrifices by those already falling behind. Economists and policymakers argued that the only way to reduce carbon emissions was through policies that would drastically lower living standards and economic growth. Taxes and regulation might be effective at lowering carbon emissions, but they would reduce the economy's ability to meet other vital needs. Public investment would be ineffective and wasteful. A massive expansion of government spending to address climate change (or anything else) was simply unaffordable, and if seriously attempted, would bankrupt the country. Thus, climate change has remained, in our political discourse, one problem among others: Small, low-cost steps are taken, but a more comprehensive solution is dismissed as not worth the cost.

American politics and policymaking have been guided by a mistaken vision of economic scarcity, which held that addressing the climate crisis must involve further sacrifices by those already falling behind.

1 For a powerful journalistic account of the ways that climate change is contributing to political instability throughout the Global South, see *Tropic of Chaos* by Christian Parenti.

The prevailing skepticism about the capacity of government, to coordinate economic activity or to finance transformational investment, has led to government inaction in the face of a number of social and economic challenges. Even when there is broad consensus that government should act , this skepticism has constrained thinking about the tools available to policymakers. Too often, policymakers see government's role as facilitating markets through tweaks like subsidies or tax incentives. We have simply excised from our public debate the notion that government can be more effective than markets at achieving certain goals.

In the case of the climate, the general rejection of government as a vehicle for collective choices about the economy has been combined with a specific frame for thinking about environmental policy. In this vision, exemplified in the work for which economist William Nordhaus recently won a Nobel prize, responding to climate change is just one good among many others. Climate responses require the allocation of some part of our fixed stock of resources, leaving less to meet other needs. These tradeoffs can, in principle, be expressed quantitatively through cost-benefit analysis, allowing many economists and policymakers to weigh the returns to limiting global warming against the value of the consumption we must give up to do so.[2]

We believe that this framing leads to a fundamental misunderstanding of the challenges at hand. It is at once too broad and too narrow and makes the problem look too easy and too hard. It is too broad because it molds climate policy into a generic claim on economic output, as opposed to a specific set of interventions needed in concrete areas of material life. It is too narrow because it focuses on one policy tool—a carbon price in the form of a tax or tradable permit—rather than looking to the full range of policy tools available to the government. It makes the problem too easy because it treats climate as one economic good among others, rather than as the fundamental condition of our social and biological existence. In this framing, even the worst outcome from climate change will cost humanity no more than a few years' worth of economic growth. But it also makes the problem too hard because it suggests that every step toward decarbonization must come at the expense of some other human need; it imagines the question as taking some part of a fixed stock of resources away from one area and devoting it to climate instead. In doing so, this framing excludes the possibility that decarbonization could mobilize currently unused resources, or that the broader social transformations it requires could raise the living standards of the majority. In the neoliberal frame, climate policy is a form of austerity—turning down the thermostat and traveling less, writ large.

Here, we argue that this framing is wrong. We do not need to choose between a robust response to climate change and meeting people's material needs today. America's collective capabilities are not fixed, and a fundamental economic and societal transformation cannot be thought of in terms of a fixed stock of resources. In tackling climate change, we should not start from the idea of an economy that is operating at full capacity, efficiently using scarce means to meet known, equitably determined ends. Contrary to orthodox theory, the US economy is not operating at its maximum productive potential and has not done so for many years. Macroeconomic policy has failed for a generation at its own stated goals, with output falling short of potential and unemployment and underemployment persistently high. This means that there is a great deal of unused capacity that a major public investment program could mobilize. And contrary to the policy orthodoxy, it is just such a public program that dealing with climate change requires—not a market-based approach of taxes and subsidies. Under a public-investment-led program like we propose here, a rapid move to a carbon-neutral economy would not imply a fall in living standards for working Americans. On the contrary, in an economy facing persistent demand constraints and weak labor markets, public spending on decarbonization will raise wages and living standards.

2 This framework, it should be noted, is broader than a preference for market solutions, though the two often go together: In this vision a carbon price is, ideally, a vehicle for allowing the tradeoff between climate and other needs to be incorporated into every private economic choice.

We do not need to choose between a robust response to climate change and meeting people's material needs today. America's collective capabilities are not fixed, and a fundamental economic and societal transformation cannot be thought of in terms of a fixed stock of resources.

Decarbonizing the economy is about transforming our economic and social realities in ways that will raise income and economic security for the great majority and improve our lives in other, less quantifiable ways. We should think of decarbonization as an opportunity to preserve a habitable planet for ourselves, our children, and grandchildren while also solving the most urgent economic problems facing us today.

Toward a Green New Deal

Despite major warnings and calls for immediate, economy-wide action from climate scientists, frontline communities, and climate activists, policymakers have so far failed to adopt a comprehensive plan to address the climate crisis. To be sure, many policymakers have developed and implemented policies to reduce greenhouse gas (GHG) emissions but not at the scale that is required. In large part, this is due to a shift in the political climate since 1980 that has led to a widespread skepticism of concerted public action to solve society's problems. The reasons for this reaction against a strong, active public sector, and against government's role as the vehicle through which we make collective choices about the society we live in, are beyond the scope of this report.[3] This shift has sharply constrained environmental policy and prevented the development of a vision to adequately address the problem of climate change.

A disbelief in the government's capacity to coordinate economic activity is a central component of the political development sometimes described as neoliberalism. While the exact meaning of this term is often debated, its central feature is a profound skepticism about democratic, collective action, especially through government but also through organizations like labor unions. Alongside this is a strong normative belief in the importance of private property rights and a positive belief in the capacity of markets to best meet social needs. Finally, there is a commonplace (though flawed) assumption that economic and broader social outcomes reflect fundamental structural constraints and not coordination failures or political choices that could be made differently. This is captured by Margaret Thatcher's much-quoted line that "there is no alternative"; in the economic realm, it is reflected through the rejection of demand side policy as a vehicle for rising incomes and living standards in favor of "supply-side" interventions, often in the form of deregulation. Overcoming this learned helplessness about public power is the essential first step toward a solution commensurate to the scale of the crisis.

In the wake of the Great Recession, we are beginning to break out of this market-centric political vision. One important manifestation of this shift in our political landscape is the emerging movement for a Green New Deal. Led by young people, including the Sunrise Movement and other environmental justice groups, Americans are mobilizing to challenge business-as-usual climate politics. High-profile public

3 To learn more about how government power has been stunted over the last 50 years, see *New Rules for the 21st Century* (Abernathy, Hamilton, and Margetta Morgan 2019).

protests have brought widespread attention to activists' demands for a much more ambitious response to the climate crisis—one commensurate with the scale of the problem. These demands have been embodied in a Green New Deal resolution, introduced in February 2019 by Rep. Alexandria Ocasio-Cortez (D-NY) in the House and by Sen. Ed Markey (D-MA) in the Senate.

The Green New Deal resolution reminds policymakers and the public alike that there is an alternative to business as usual. We do not have to choose between economic growth, economic justice, and environmental protection. We can reclaim a more robust vision of government that is capable of coordinating and financing economic transformation. The Green New Deal proposal argues that the effort to decarbonize the economy will build the country's resilience against climate change, turbocharge the growth of good jobs, build a carbon-neutral economy, and ensure that the people who have historically been left behind are fully included in this massive transformation of our economy and society. We argue that the economics behind this vision is sound.

Overcoming this learned helplessness about public power is the essential first step toward a solution commensurate to the scale of the crisis.

This report provides a policy framework and sample policies to decarbonize the US economy and build robust pathways toward a more comprehensive Green New Deal. We believe a policy framework to decarbonize the economy should include three broad pillars. The first pillar is large-scale investments planned, facilitated, and, in some instances, directly undertaken by the government. The second pillar is comprehensive regulation to ensure decarbonization across the board—in a way that can command broad public support. The third pillar is carbon pricing: Specifically, a cap-and-dividend system that incorporates the full cost of GHG emissions into market prices while avoiding the steeply regressive impact of a carbon tax. Together, these three approaches will allow for rapid decarbonization, while raising living standards and avoiding the massive economic disruptions that would come from a carbon tax large enough to reduce emissions to a sufficient degree.

The benefits of such a program are immense. From an environmental perspective, the climate benefits of averting global warming beyond 1.5°C are impossible to overstate. Holding to this temperature would avert many climate tipping points, cut extreme heat waves, reduce species loss, limit the rise of sea levels, curtail ecosystem collapses, and more. Lives will be saved as fewer people will be in the path of extreme storms, rising seas, and devastating droughts. This alone should be sufficient justification for a program of crash decarbonization, even if it were economically costly. Notably, the program need not be costly in real-resource terms. In an economy facing chronically weak demand, a massive program of decarbonization can greatly boost output, productivity growth, and living standards. It will call forth technological improvements that would otherwise not be made and move millions of people from unemployment or underemployment to rewarding, high-productivity jobs. From an equity perspective, a decarbonization program that emphasizes targeted public investment can address the glaring inequalities that are one of the outstanding faults of today's economy.

One of the simplest but most fundamental economic shifts that a Green New Deal will bring about is a move toward a "high-pressure" economy. This is an economy that is consistently producing as much as it can and where, in particular, there are more jobs available than there are workers rather than the reverse. Traditionally, policymakers have seen this as something to avoid, fearing that the rapid wage growth of such an economy could lead to rising inflation. But it is increasingly clear that these fears were exaggerated, while the benefits of a high-pressure economy have been ignored. A tight labor market does indeed lead to higher wages; but today those higher wages more often come out of profits or lead to higher productivity, rather than being passed on to prices. A high-pressure economy may come about when private demand is very strong, as was briefly the case in the late 1990s; but to be sustained, it requires macroeconomic policy to be pushed in a more expansionary (demand-boosting) direction than has been the case in recent decades; and in particular, it requires a large, sustained increase in public spending.[4]

We do not have to choose between economic growth, economic justice, and environmental protection. We can reclaim a more robust vision of government that is capable of coordinating and financing economic transformation.

A high-pressure economy disproportionately benefits those at the back of the hiring queue—people of color, young people, those with less education or criminal records. The sustained strong demand created by decarbonization will do a great deal to reverse the fall in wages over the past decades and level the playing field between labor and capital. Decarbonization can also address inequities more directly, by providing transit and other essential public goods and by reducing fossil-fuel uses that disproportionately burden low-income communities and communities of color (PERI 2018). More broadly, decarbonization can prioritize providing economic opportunities for those facing the greatest economic insecurity. This will both lead us to a more just society and help mobilize the support that the program requires. From an economic perspective, mobilizing the productive capacity of the economy through large-scale public investments will profoundly reshape our economy in ways that will not only help avert catastrophic climate change but will also boost economic growth and lay the foundations for a strong and sustainable 21st century economy designed to meet real human needs.

A comprehensive package to decarbonize the economy may require investments on the scale of 5 percent of GDP per year, which would be roughly $1 trillion annually, sustained over a 10-year, or more, period. While a large part of this will come from private capital, we expect that annual public spending will be increased by 3 to 5 percent of GDP.[5] This will require a reorientation of a still-dominant ideology that has minimized the positive role of government and emphasized a false tradeoff between economic growth, job creation, and a clean environment. In place of the neoliberal vision of the past 50 years, we must revive the economic vision of John Maynard Keynes, in which only government has the long time horizons and freedom from market pressures to undertake many vital investments, and in which public spending does not crowd out spending to meet private

4 For more on high-pressure economies, see Ball (2015) and Bivens (2017).

5 Other researchers have come up with a ballpark price for investments associated with decarbonization. One report estimated that a reduction in emissions of 80 percent by 2050 would require an average of $330 billion a year over 30 years. If this were to be undertaken in say 10 years, the required investment would likely exceed $1 trillion a year across 10 years (Risky Business 2016). Others, such as Michael Liebreich (2019) at Bloomberg, estimate that a decarbonization program will cost an estimated $980 billion a year for 10 years. Each of these are in line with roughly 5 percent of GDP a year in investments.

needs but supports and reinforces it. A sound approach to climate policy that stimulates aggregate demand can boost private production, jobs, and wages, and protect those communities who have been left out by a markets-first approach (Barbier 2010; Pollin 2015). This approach is ambitious, but it is not utopian; it builds on work that has already begun. After all, green jobs are amongst the fastest-growing jobs in America (SEIA 2017). Under such a framework, and given our macroeconomic condition discussed below, the vast spending associated with decarbonizing the economy should not be viewed as a cost but as a benefit.

Together, these three approaches will allow for rapid decarbonization, while raising living standards and avoiding the massive economic disruptions that would come from a carbon tax large enough to reduce emissions to a sufficient degree.

To be clear, the policies identified within this report are not a comprehensive list of all that is needed to address environmental problems, nor do they cover the entirety of what is usually meant by the Green New Deal. Many vital issues, such as the need for clean water, eliminating harmful pollutants, and restructuring utility markets, are not covered here. While the policies discussed here are all aimed at decarbonization, this is not meant to minimize the importance of complementary social policies within a broader Green New Deal, such as universal health care and a job guarantee.[6]

This will require a reorientation of a still-dominant ideology that has minimized the positive role of government and emphasized a false tradeoff between economic growth, job creation, and a clean environment.

Our more limited focus should not be taken as a suggestion that the broader range of policies envisioned in the Green New Deal resolution is irrelevant to climate policy or a dispensable supplement to it. Rapid decarbonization will fundamentally reshape our economy in ways that have major effects on the labor market, and the distribution of income and wealth. A decarbonization program that ignored the massive inequalities that define our economy would nonetheless be shaped by them and would reshape them for better or worse. What distinguishes the Green New Deal approach is not that it engages with existing inequities of race, gender, education, and geography, but that it does so in a conscious and deliberate way. A decarbonization program that ignored these inequities would risk reinforcing them, thus repeating the mistakes of the original New Deal. A narrow focus on decarbonization also throws away one of the strongest bases of political support: the promise to address our urgent economic problems in the present.

6 For more on a federal job guarantee program, see Paul et al. (2018).

The reality is that our economy, suffering from chronically weak demand, underemployment, and massive inequality, would be in need of a new New Deal even if there were no climate crisis. Addressing our environmental and economic problems together makes sense both substantively and politically. Far from being a progressive wish list, the Green New Deal approach is simply taking our overlapping crises seriously. As recent events in France demonstrate, environmental policies that exacerbate existing inequalities risk a ferocious backlash—and justifiably so.

It is important to note that our policy framework does not reject market approaches across the board. Some form of carbon pricing has a place in a broader decarbonization strategy. It does, however, reject the narrow-minded ideology that markets can or should be the primary form of economic coordination. Prices may effectively guide decision-making at the margin, where it is a question of choosing between a few well-defined alternatives. But for a large-scale economic transformation, involving a range of new activities carried out across many sectors, market coordination quickly breaks down. Contrary to the neoliberal ideology, we take a more positive view of government. Government action should not be limited to correcting a few defined market failures or internalizing externalities, and it should not be a last resort that is only utilized when market solutions are not available. For a problem like climate change, public provision—one of the government's distinct strengths—should often be seen as a first choice, not a last resort. Markets are not a natural force beyond our control; they are largely the creation of government, which establishes property rights and sets the rules on which they can be exercised and exchanged. The government further shapes market outcomes through taxes and transfers, through an array of regulations, through the Federal Reserve's responsibility for credit conditions and the overall level of economic activity, and through direct public provision of a raft of essential services. We believe that the public sector must play the leading role in directing decarbonization and in a broader Green New Deal movement. Accordingly, the framework outlined in this report builds on the existing roles and capabilities of the federal government to reshape the economy in a conscious, deliberate way that centers the interests of a habitable planet and an economy that supports human flourishing.

We believe that the public sector must play the leading role in directing decarbonization and in a broader Green New Deal movement.

Outline of the Report

In this report, we offer a number of proposals for decarbonizing the US economy, as part of a just transition from an economy based on fossil fuels to a net carbon-neutral economy that protects the livelihoods of both current and future generations and our planet. We believe that a program to rapidly reduce carbon emissions should be part of a broader agenda to address the injustices, instability, and waste of human potential that our economy generates. But in this report, we have chosen to focus on the climate policies. Future work should address other complementary aspects of the broader Green New Deal agenda.

While identifying and breaking out of the neoliberal shackles that have contributed to our environmental and inequality crises are important, so too is developing a concrete policy framework for decarbonization. We see our proposals not only as steps toward meeting our climate goals but also toward rethinking the rules of our economic system, and toward realizing the productive potential of our economy, by creating a high-pressure economy that prioritizes rising wages and full employment.

The report is organized as follows:

In Section 1, we introduce our policy framework and provide 12 sample policies that should be considered as policymakers build a program for decarbonizing the US economy. The section builds the case that government investment, environmental regulations, and policies to get prices right in the market should be viewed as complementary tools in our effort to decarbonize. Setting clear policies to facilitate the process of phasing out fossil fuels will help neutralize the power of the fossil fuel industry in halting climate action and will drastically reduce government support for the industry responsible for global warming. The second policy area, building the carbon-neutral economy, provides a swatch of policies ranging from direct government investment in mass transit to electric vehicle mandates to policies to direct credit to green businesses that are critical for decarbonization.

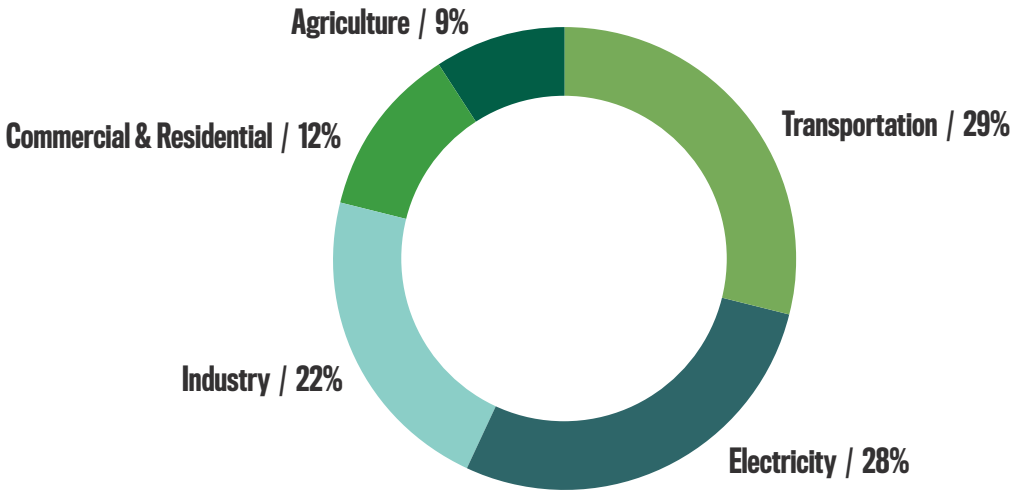
In Section 2, we present the macroeconomic case for a Green New Deal. This section first argues that there is significant unused capacity in the economy. As things stand, we are not fully deploying our society's resources. Second, this section addresses the "How do we finance it?" question. Significant spending must be undertaken to decarbonize the economy, which, rather than crowding out private investment or resulting in unsustainable levels of debt, would actually be a boost to the economy; given current macroeconomic conditions, more robust spending can aid the economy in approaching true full employment. Increased public spending will, reliably, lead to tighter labor markets and faster wage growth. But this impact will not fall equally across regions, occupations, or demographic groups. Without active measures to manage its distributional impact, it may well widen some inequalities even while narrowing others. And as recent events in France demonstrate, environmental policy that ignores existing inequities invites a ferocious backlash. In sum, we argue that, as economists, we see decarbonization and the broader Green New Deal movement as eminently reasonable. As human beings, we see it as a necessity.

The State of GHG Emissions

In order to effectively design a framework and set of policies to decarbonize the economy, we must first be aware of the current state of GHG emissions throughout the US. While emissions are growing significantly at the global level, domestic CO_{2e} emissions peaked in 2007 at 7,351 million metric tons of CO_{2e} and have since fallen by roughly 10 percent to 6,457 million metric tons of CO_{2e} (EPA 2019). Despite this modest decline, emissions have started growing again and are not on a phase-out trajectory.

FIGURE 1:

Total US Greenhouse Gas Emissions by Economic Sector (2016)



Total emissions in 2016 were equal to 6,511 million metric tons of CO2 equivalent. Source: United States Environmental Protection Agency.

Figure 1 breaks down GHG emissions by economic sector in the US economy. As we can see, transportation and electricity are the two largest contributors of emissions in the economy. They are perhaps also the easiest to imagine decarbonizing. For the electricity sector, responsible for 28 percent of US GHG emissions, the economy would need to replace fossil fuel power with clean and renewable energy, including storage. Surpassing electricity in 2017 for the first time, transportation is now the largest emitting sector. Emissions from this sector can be broken down into the following categories: light-duty vehicles (60 percent); medium- and heavy-duty trucks (23 percent); aircraft (9 percent); rail (2 percent); ships and boats (2 percent); other (4 percent) (EPA 2018b). While decarbonizing the bulk of transportation would require the electrification of cars and trucks, some parts of transportation are much harder to abate, such as heavy shipping and air travel.

Commercial and residential buildings account for 11 percent of emissions and are largely attributable to the heating, cooling, and the general energy needs of buildings designated for commercial and residential use in the US. As we will discuss below, decarbonizing these areas would require carbon-neutral buildings powered entirely by clean and renewable electricity.

The last two sectors present some of the largest challenges to decarbonization. Emissions attributed to the industrial sector account for 22 percent of total US emissions and are associated with energy use and process emissions. Of these, process emissions are the primary challenge, as many industrial processes, such as cement clinker manufacturing and the production of high-grade coke, an important element in steelmaking, emit GHG emissions that are not associated with the combustion of fossil fuels.

Finally, agriculture, which accounts for about 1 percent of the US economy in terms of GDP, is responsible for 9 percent of US emissions. Most of these emissions can be attributed to agricultural soil management; however, enteric fermentation (part of the digestion process for ruminants, such as cows and goats) and manure management are also major contributors of emissions. The agricultural sector will require its own sets of policies to effectively decarbonize.

SECTION 1

Policy Framework & Sample Policies

Our policy framework for decarbonizing the US economy starts from the premise that we need to fully mobilize our productive capacities through a variety of policy levers to rapidly address climate change. We break these down into three complementary pillars: carbon cap-and-dividends, climate regulations, and public investments, which include credit policy. This framework acknowledges that actions sufficient to rapidly decarbonize the economy require us to utilize all of the tools at our disposal. While market-centric policies will likely be part of the broader climate solution, they should be implemented alongside environmental regulations and direct government investment. This will ensure that climate targets are met, carbon-neutral public goods and services are expanded, and the economy is brought to, and sustained at, full employment.

In this section, we first introduce and discuss our policy framework. We then provide sample policies to effectively phase out fossil fuels and build the carbon-neutral economy. While these are not meant to be a comprehensive list of policies to decarbonize the economy or to encapsulate the Green New Deal, they are examples of policies that should be part of any comprehensive plan for decarbonization.

The Role of Carbon Pricing

Rapidly transitioning the economy to net carbon neutral will be a major undertaking. According to many economists, who largely recognize climate change as a serious threat, a price on carbon is the key tool to achieve this goal. Four former Federal Reserve (the Fed) chairs, 27 Nobel laureates, and over 3,000 economists recently signed a petition stating that "a carbon tax offers the most cost-effective lever to reduce emissions at the scale and speed that is necessary" (CLC 2019).

There is an element of truth to this. Putting a price on carbon will change calculations about the mix of energy sources for electricity producers, when to rely on car-based transportation, what temperature to set the thermostat, how often to fly, which production methods to use, etc. Indeed, it is hard to imagine fundamentally changing these decisions *without* increasing the cost of these activities in proportion to their contribution to climate change.

At the same time, a simple carbon tax is, as a form of a consumption tax, highly regressive. Low-income people spend a large part of their income on transportation, heating and cooling, and other basic needs whose cost will go up under any carbon pricing system, while the rich spend only a small fraction of their income in these areas. So, any carbon-pricing policy must be accompanied by a carbon dividend to redistribute the revenue on an equal per-capita basis. But even with a dividend, a carbon price alone is not sufficient to achieve an equitable deep decarbonization of the economy by itself.

To solve these sizable problems, we need a sizable actor: the government.

In the idealized world of economic models, placing a price on carbon perfectly aligns the incentives of households, firms, and governments with those of society. Even in this ideal world, though, the carbon tax must be high enough to internalize the full cost of carbon emissions. Many carbon tax advocates shrink away from this, instead proposing exceedingly low prices on carbon—often in line with 3.5°C+ of warming—while simultaneously claiming that this market mechanism can replace environmental regulations and government investments. Conversely, a carbon tax high enough to, by itself, achieve our climate goals would be immensely disruptive.

We must avoid the false trichotomy between regulation, public investment, and carbon pricing. Carbon pricing does have a place, but we can see the limits of carbon pricing as soon as we look beyond the idea of a perfectly competitive economy as it is described in introductory economic textbooks. Real economies are characterized by numerous imperfections, including bounded rationality, asymmetric information, economies of scale, and coordination problems. Additionally, these real-world economies—the contemporary US in particular—also face persistent shortfalls of effective demand, which require active government intervention to bring spending up to the economy's potential. Large-scale public investment is a complement to carbon pricing. While the carbon price helps ensure that prices in the market reflect emissions targets, investment will provide the necessary infrastructure and credit to build the carbon-free future—putting idle resources to use as we pursue a high-pressure economy.

Though markets can be effective at allocating resources—when the alternatives are well-known, the required adjustments are small, and the outcomes are relatively certain and immediate—markets are insufficient when there is a need to quickly reorient a complex system of production and distribution toward goals that are far off and hard to observe, as with climate change. This is when the price mechanism breaks down. For instance, just because a carbon price will increase the price of gasoline doesn't mean that people will have adequate access to alternative modes of transportation that would allow them to easily change their behavior such as public transit. To solve these sizable problems, we need a sizable actor: the government. It's one thing to count on market signals to guide consumers as they choose between bananas and apples in the grocery store. It's quite another to claim that price signals alone can guide a massive redirection of the economy on the scale of required for a Green New Deal.

Though markets can be effective at allocating resources–when the alternatives are well-known, the required adjustments are small, and the outcomes are relatively certain and immediate–markets are insufficient when there is a need to quickly reorient a complex system of production and distribution toward goals that are far off and hard to observe, as with climate change.

The Role of Regulations

Some economists promote a carbon tax as an alternative to cumbersome regulations (CLC 2019), but prices and regulations can be complements, rather than substitutes. Regulations can have many benefits, including the fact that mandating clean energy use can cause the cost of clean technology to fall as it is widely adopted. In 1975, for example, the Environmental Protection Agency (EPA) required new gasoline-powered vehicles to be equipped with a catalytic cconverter. This act sharply reduced carbon monoxide emissions at a significantly lower cost than imposing a tax on carbon monoxide.

While in some sectors of the economy, like the electricity sector, a carbon price may be relatively effective, other sectors may require complementary regulation to direct the decarbonization process. To accomplish our climate goals, it's clear that we'll need both. Regulation can provide a cost-effective and realistic method of reducing emissions. It also has a proven track record. Since 2000, 62 percent of the growth in non-hydro renewables in the US has been to satisfy requirements set forth by renewable portfolio standards—regulations that require states' utilities to get a minimum percentage of their power from renewable energy (Barbose 2015).[7]

We can observe other examples of regulations that are more tangible. For instance, consumers regularly fail to purchase products with higher upfront costs, such as a more fuel-efficient car or home, even when

7 Though economists frequently quibble about renewable portfolio standards (RPS), recent research has demonstrated that their benefits far outweigh their costs. Existing RPS across 29 US states and Washington, DC, result in an estimated $31 billion in increase costs; however, they provide an estimated $97 billion in air-pollution health benefits and $161 billion in climate damage reductions under conservative assumptions (Wiser et al. 2017). In this report, we propose an economy-wide carbon price, but if an enhanced RPS is more politically palatable, it provides a good alternative for the electricity sector.

more efficient products save money in the long run (Gillingham and Palmer 2014). This energy efficiency gap is due partly to the fact that consumers have imperfect information about the lifetime cost of goods; and corporations, retailers, and landlords often have an incentive to keep it that way. The gap also results from the fact that people are not human calculators. Limits both to information and the decision-making capacities of individuals and organizations often prevent people from making the "correct" response to price signals such as those brought about by a carbon price. A program to decarbonize the economy should similarly embrace regulations that effectively cut GHG emissions.

The Role of Public Investment

A carbon price plus environmental regulations still aren't sufficient to achieve an equitable decarbonization of the economy, especially considering the current output gap. Students of economic transitions, such as those that occur in economic development, have long recognized that successful industrialization doesn't happen purely via market signals and regulations; the state always plays a coordinating role and must manage aggregate demand. Similarly, there is a reason that large businesses have professional managers to plan their operations rather than relying on internal markets to allocate labor and capital.

Public investment is a crucial component of a program to decarbonize the economy, because it is also necessary to exploit economies of scale, solve coordination problems, and bring the economy to full capacity to transition as rapidly as possible while providing true full employment. While a carbon price coupled with environmental regulation will provide households, firms, and governments with an incentive to ditch fossil fuels, collective action is often necessary to build the carbon-free alternatives of the new economy. Public investment is necessary for things such as: retrofitting buildings, providing green transportation, building a green national grid, increasing research and development (R&D), and adapting to climate change that is already locked in.

There is good reason to think that our economy is still operating well below full capacity. Real GDP today is more than 10 percent below the level predicted a decade ago, and at least some of this gap reflects lingering weak demand following the Great Recession (Mason 2017a). Millions of workers remain unemployed and outside the labor force despite relatively low headline unemployment numbers. The government could effectively close the output gap by engaging in large-scale public spending, which can break us out of our current hysteresis—which, as explained in Section 2, refers to the lasting effects of demand conditions, especially weak demand, on potential output—and raise the economy's productive capacity in the long run. After all, the transition required demands significant *investments* in our people and our economy; investments that will pay off for decades and centuries to come.

This policy framework for decarbonization recognizes the complementarity of carbon pricing, regulation, and public investment. Consider the example of transportation, which is currently responsible for 28 percent of US emissions. Putting a significant price on carbon—and indirectly on gasoline—will reduce emissions, but the "right" price will not automatically produce the "optimal result." First, a combination of imperfect information, bounded rationality, and credit constraints leads consumers to purchase cars that generate too many emissions. This provides a justification for direct regulations, including a continued tightening of the corporate average fuel economy (CAFE) standards and ultimately an electric vehicle (EV) mandate.

While a transition to EVs is vital, it's also important to note that the most cost-effective way to decarbonize transportation will also entail a dramatic shift away from driving and to mass transit, cycling, and walking (McKinsey 2017). A carbon price does modestly increase the incentive for federal, state, and local governments to invest in buses, light rail, and bike lanes, but it does not eliminate the coordination problem in revamping transportation infrastructure. Nor will it build the EV fast-charging infrastructure that is critical to enabling widespread EV adoption. This is why public investment is crucial, as it will provide funding for effective projects that actually give people access to green transportation.

In sum, we need them all: carbon pricing, regulations, and large-scale public investments to transition the economy to a net carbon-neutral future. Public investment is crucial to building the human and physical infrastructure of the new economy. Without it, not enough dollars will flow to transition the economy, the economy will fail to reach full employment, and policymakers will continue leaving millions of people without work or wage increases. Regulations are necessary to ensure dirty industries and practices are phased out as the investments roll out clean alternatives to business as usual. Additionally, these regulations are vital for environmental justice concerns, such as the siting of polluting industries and fossil fuel extraction activities. And carbon pricing creates a more level playing field in the market and redistributes revenue in a progressive fashion. Together, these can be utilized to phase out fossil fuels and build the carbon-neutral economy we need.

1.1 Phasing Out Fossil Fuels

If the US is to rapidly reduce GHG emissions and transition to a carbon-neutral economy in the next few decades, it must quickly phase out the bulk of the fossil fuel sector. While fully accomplishing this goal will require a suite of policies, below we discuss three essential policies that will tame fossil fuel power and rapidly shrink the sector as the economy is set on a path toward full decarbonization: 1) eliminate subsidies for fossil fuels; 2) halt new fossil fuel extraction; and 3) implement a carbon cap-and-dividend program to ensure that emissions goals are met while protecting the incomes of most people.

During the past two centuries, fossil fuels have allowed for impressive industrialization and high levels of economic growth; however, the extraction of these fuel sources has devastated the environment that many communities depend on, and their combustion is responsible for the climate crisis humanity is currently facing. Addressing this crisis necessitates that the vast majority of fossil fuels are phased out as quickly as possible, limiting the additional emissions to be released into the atmosphere and increasing demand for alternatives to the dirty economy as we know it.

Embarking on this process will require both supply- and demand-side policies. On the demand side, which has been favored by policymakers and researchers to date, we can think of countless policies to reduce the demand of fossil fuels through initiatives to support cheap renewable energy, EVs, energy efficiency upgrades, etc., all of which will be discussed below in the section on investing in decarbonization. But reducing the actual supply of fossil fuels and in turn reducing the size of the industry as a whole, will also help constrain the political influence of fossil fuel corporations and allies—which is vital to addressing climate change in a timely manner. Importantly, policymakers should stop favoring the fossil fuel industry in the first place. Cutting off policies that favor the industry will help keep remaining fossil fuels in the ground, while also engaging in measures to reel in the political influence of the industry—influence it has relentlessly used to halt climate progress and fuel climate denialism.

The fossil fuel industry wields immense political power, allowing the industry to halt progress on climate efforts to rapidly reduce emissions by heavily influencing policymakers on both sides of the aisle. Phasing out fossil fuels necessitates keeping fossil fuels in the ground, which will create massive stranded assets, currently valued at an estimated $100 trillion globally, according to a Citigroup report (Channell et al. 2015). Any policies to slow or stop the development of these fossil fuel assets, while critical to meeting emissions targets, will be vehemently opposed by the fossil fuel industry. Since the early 1980s, fossil fuel companies and groups such as the American Petroleum Institute have been publicly downplaying any concerns related to global warming. Recently, we have seen many examples of the industry's political influence. During the 2018 election cycle, for example, fossil fuel lobbies poured in $100 million to defeat three modest state-level environmental initiatives (Aronoff 2018). At the national level, we see that four-fifths of the energy sector's political donations in the 2017-2018 election cycle, amounting to $8.5 million, went to Republican candidates (Stevens 2018). At the multinational level, the fossil fuel industry has unloaded over $1 billion to sell themselves as a climate "ally" to the public, marking a reorientation from climate denialism to the notion that fossil fuels should play a major role in the "clean" future through the deployment of technologies yet to be proven (Kaufman and D'Angelo 2019). To tackle climate change, we must address these entrenched powers that benefit from the status quo and seek to stop any actions to transition away from it by taming the corporate power of fossil fuels. Below, we recommend policies to rein in corporate polluter power.

Phasing out the bulk of the fossil fuel industry, while necessary, will pose significant challenges for fossil fuel workers and their communities, which is why public power is necessary in the transition to a green economy. Disrupting the fossil fuel economy will necessitate that hundreds of thousands of fossil fuel workers are transitioned into high-quality union jobs and must not bear the brunt of this transition.[8] While some just transition programs have been developed—such as the one by economists Robert Pollin and Brian Callaci (2016) to retrain and, where necessary, relocate fossil fuel workers, guarantee their pensions, guarantee employment in the clean energy sector, and transition communities dependent on the fossil fuel industry—much more work is needed to ensure an effective just transition that truly benefits workers and their communities. Precedent provides policymakers with crucial insight on building a truly just transition program for fossil fuel workers: The various attempts at trade adjustment assistance (TAA) policies for workers, for instance, have proven insufficient to protect workers and communities from economic shocks associated with trade agreements. Much like the original New Deal, we can learn from both the successes and failures of past policy choices.

Transitioning to a carbon-neutral economy will require a sizable shift in the deployment of the economy's productive capacities, transitioning them away from the fossil fuel sector and toward the clean and renewable economy of the future. Building the carbon-neutral economy is essential, but getting the fossil fuel industry out of the way by deploying sensible, inclusive policies is an important first step. Paying polluters to extract and emit harmful fossil fuels simply needs to end, and new investments in fossil fuel extraction infrastructure must cease. A carbon cap-and-dividend will function as a vital backstop to ensure that the fossil fuel industry is largely phased out in a timely manner to meet our emissions goals while protecting the purchasing power of most people, and low-income communities in particular, throughout the United States.

8 Other sources argue that there are closer to 1.1 million workers in oil, gas, and coal jobs, including 467,648 in the mining and extraction of fossil fuels plus nuclear (DOE 2017).

Eliminate Fossil Fuel Subsidies

Summary

Fossil fuel companies in the US heavily rely on government subsidies to make drilling, mining, and extracting feasible, amounting to approximately $20 billion per year (Redman 2017). These corporate payouts not only sustain current fossil fuel extraction, but they also incentivize expansion into new fossil fuel projects. The US government should cease subsidizing the fossil fuel industry through a full repeal of existing subsidies to the coal, oil, and natural gas industries.

Background

Historically, the US government has chosen to subsidize the fossil fuel industry to a significant degree. These subsidies amount to large transfers from the government to the fossil fuel industry.[9] Handouts such as these help to prop up the existing fossil fuel sector and are largely responsible for driving up fossil fuel extraction and use in the economy. The subsidies, initially put in place to stimulate fossil fuel extraction and further develop domestic fossil fuel assets, are partly responsible for access to cheap fossil fuels. If the government were to stop paying these polluters through state and federal subsidies, it's estimated that almost half of all new US oil production would be unprofitable and thus left undeveloped (Erickson et al. 2017). Additionally, fossil fuel subsidies represent an obstacle to renewable energy investment by artificially increasing the relative cost of renewable energy (Carbon Pricing Leadership Coalition 2017). While there is some disagreement in the literature on how much of a reduction in carbon emissions would be achieved by repealing fossil fuel subsidies, studies largely agree that fossil fuel subsidies constitute a government handout to pad the profits of fossil fuel companies (Coady 2017; Jewell 2018).

According to Oil Change International, the US government spends approximately $20.5 billion subsidizing the fossil fuel industry, $14.7 billion of which comes from federal subsidies and another $5.8 billion from state subsidies (Redman 2017).[10] Others contest subsidies are lower, amounting to roughly $8.7 billion as outlined in the *US Self-Review of Fossil Fuel Subsidies* conducted under the Obama administration in 2015 (OECD 2015). These estimates are lower primarily due to the fact that they focus on tax preferences specific for the fossil fuel industry.[11]

9 For the purposes of this report, a fossil fuel subsidy is "any government action that lowers the cost of production, lowers the cost of consumption, or raises the price received by producers. Types of fossil fuel subsidies include financial contributions or support from the government or private bodies funded by the government, including direct transfers of funds; transfer of operating or accident risks, such as by capping liability; foregone revenue including tax breaks; and provision of goods and services at below-market rates" (Redman 2017).

10 This leaves out important consumer subsidies including the Low Income Home Energy Assistance Program (LIHEAP), which helps families pay their heating bills. According to the Division of Energy Assistance and Office of Community Services, LIHEAP has released $3.65 billion for the federal fiscal year 2019 (LIHEAP 2018); total consumption subsidies amount to $14.5 billion.

11 In terms of the international community, the numbers are far larger, with an estimated $5.3 trillion in fossil fuel subsidies across the globe, or 6.5 percent of global GDP, according to economists at the International Monetary Fund who try to take into account post-tax subsidies as well, including the environmental and health costs of pollution (Coady et al. 2017).

FIGURE 2:

Top 10 Federal Subsidies to Fossil Fuel Companies

Top 10 Federal Subsidies to Fossil Fuel Companies	2015-2016 U.S. Average Millions of $
Deduction for Intangible Drilling Costs	2,292
Last-In, First-Out Accounting for Fossil Fuel Companies	1,690
Corporate Tax Exemption for Fossil Fuel Master Limited Partnerships	1,614
Excess of Percentage Over Cost Depletion	1,310
Lost Royalties on Offshore Drilling	1,072
Powder River Basin Coal Lease Subsidy	963
Domestic Manufacturing Deduction for Oil & Gas Extraction	805
Fossil Energy R&D	591
Dual Capacity Taxpayer Deduction	530
Amortization Period for Coal Pollution Control	450

Figure 2 displays the top 10 federal subsidies handed out to fossil fuel companies.[12] The 10 major federal subsidies alone amount to an annual transfer to the fossil fuel companies of $11.3 billion, while the remaining $9.2 billion can be found in over 100 additional subsidies accessible to these polluting companies.[13] To put these numbers into context: Fossil fuel firms receive seven times more subsidies in terms of permanent expenditures than the entire renewable energy sector does (Redman 2017).

Eliminating these payments would bring about important changes for fossil fuel investment returns and production decisions. These could include reducing GHG emissions through slowing current extraction, halting development of new fossil fuel infrastructure investments, lowering profits of existing fossil fuel firms, and freeing resources currently directed at the fossil fuel industry to be deployed in building the green economy—all without having a negative effect on economic growth (Monasterolo and Raberto 2019).[14] Experts also agree that this would not put US energy independence at risk, a common line for people pushing the mantra "drill, baby, drill" (Aldy 2013). Eliminating these corporate payouts will raise fossil fuel prices while freeing up additional resources for the rapid decarbonization of the US.

12 A complete list can be found in Redman 2017. Note that 80 percent of subsidies flow to oil and natural gas while 20 percent flows to the coal industry.

13 If we break down these subsidies by stage of production, we find that 17 percent are for remediation–cleaning up the environmental messes and abandoned resources left behind by fossil fuel companies. With the financial future of fossil fuel firms in jeopardy, there's a legitimate concern that the government could be responsible for far more environmental cleanup from these destructive practices.

14 It is also worth noting that these authors find that fossil fuel subsidies have a higher negative distributional effect than green subsidies.

To put these numbers into context: Fossil fuel firms receive seven times more subsidies in terms of permanent expenditures than the entire renewable energy sector does.

Sample Policy

The US should repeal all existing fossil fuel subsidies. There are 16 provisions in the US federal tax code that currently subsidize fossil fuel producers and could be eliminated to roll back fossil fuel subsidies by an estimated $8.7 billion per year (Aldy 2013; OECD 2015). With a total of $20.5 billion per year in subsidies, this rule change would represent an approximately 40 percent cut to existing subsidies—though policymakers should work to eliminate all fossil fuel subsidies. Excluding the $8.7 billion documented above, the remaining subsidies amount to an additional $6 billion at the federal level and $5.8 billion across US states. Congress, in partnership with the US Treasury and state governments, should end polluter welfare by fully eliminating these subsidies.

Halt New Fossil Fuel Extraction

Summary

The US should halt new fossil fuel extraction by stopping new permits for extraction infrastructure, ending new leases on public lands for extraction, and establishing a buffer zone between oil and gas wells and schools, homes, and businesses. This will ensure that known fossil fuel reserves largely stay in the ground and that public lands, a vital area of natural wealth, are protected.

Background

The fossil fuel industry extracts the oil, gas, and coal that the US burns to fuel its cars, homes, buildings, and industries. As of 2016, the emissions of CO2 released from the combustion of fossil fuels accounted for 80 to 85 percent of total US GHG emissions (EIA 2018). While the historic use of fossil fuels unlocked a century and a half of unprecedented growth both domestically and abroad, we must now rapidly phase out fossil fuels to avoid catastrophic global warming. Policies that aim to diminish demand for—or disincentivize the use of—fossil fuels are necessary, but it is critical to attack the problem from the often-ignored supply side as well.

According to a recent analysis by Oil Change International, if the US continues on its current trajectory, it will drive about 60 percent of the growth in global oil and gas extraction (Trout and Stockman 2019). This puts US policy at odds with the fact that global emissions must be rapidly reduced to net neutral if the US and the global community are to have a reasonable chance at limiting global warming to 1.5°C. To meet these goals, an estimated 80 percent of known fossil fuel reserves will have to be left in the ground (Ritchie 2017). Once fossil fuel companies invest in new infrastructure, they extract fossil fuels until the operating costs exceed the price of their product. Thus, extraction infrastructure effectively "locks in" an emissions trajectory that makes reaching our emissions targets unattainable.

The activist community has long understood this challenge and has led the charge on climate change with a number of successful campaigns to halt new fossil fuel extraction and to dismantle existing fossil fuel infrastructure. Naomi Klein, Bill McKibben, and other activists, including bold youth movements, have built support across the US around ideas that #KeepItInTheGround through Blockadia, divestment, and the nationalization of the fossil fuel sector (Greenpeace n.d.; 350.org n.d.; Klein 2014). Activists have also been fighting this battle in the courts, arguing that the US government has failed to consider climate change and future generations when allowing for new fossil fuel infrastructure and leasing (Schwartz 2018; Crooks 2019).

Policies to curb fossil fuel infrastructure have already been enacted at the local level. For instance, Portland, Oregon, banned all new fossil fuel infrastructure in 2016 and banned the expansion of current fossil fuel facilities, using a zoning ordinance (Hirji 2016). The measure has already withstood court challenges (Danko 2018). King County, Washington (home of Seattle), also recently passed a temporary moratorium on new fossil fuel infrastructure (Smith 2019). While these are positive developments, we need national action in order to halt new fossil fuel infrastructure, which is just the beginning, and indisputably, a necessary step in radically shrinking the fossil fuel industry.

Sample Policy

To limit the extraction of fossil fuels, the government should first ban new leases and permits for additional fossil fuel exploration, production, transportation, and storage as well as revoke proposals already in the pipeline. Beyond these steps, the government should also significantly increase the severance tax for existing leases and establish a buffer zone, or setback, between oil and gas wells and homes, schools, and businesses.

Implement a Carbon Cap-and-Dividend Program

Summary

Currently there is no national carbon tax or carbon cap on emissions in the US. To ensure that the US meets its emissions targets and does so in an equitable fashion, we propose the creation of a nationwide carbon cap-and-dividend program. This is a relatively straightforward policy that forces polluters to pay for the emissions they dump into the atmosphere. Our policy is structured to ensure that emissions are reduced in line with ambitious emissions targets, avoid commodifying or financializing[15] the environment, and protect the purchasing power of those most in need: low-income communities and communities of color. This policy should be paired with complementary environmental regulations to eliminate the co-pollutants that have contaminated the air, water, and land, and afflicted the health of environmental justice communities for generations. While a carbon cap is by no means a silver bullet to the climate crisis, a well-designed carbon cap can bring sizable, lasting benefits to current and future generations, promote equity, and reclaim common ownership over our environment.

Background

Currently, polluters are largely free to emit CO_{2e} into the atmosphere and do not have to pay for the environmental and health damages associated with burning fossil fuels (Boyce 2018). To correct this, policymakers and economists have been debating a set of policies for decades to put a price on carbon with an aim of reducing emissions. The point of this type of policy is to price the externality—the

15 We define "financialization" as the outsized growth of the financial sector and its increased power over the real economy.

pollution and damages from fossil fuels that are not reflected in current prices—which would help address what economist Nicholas Stern refers to as "the greatest market failure the world has ever seen" (2007).

A price on carbon can come in two forms: a carbon tax or a carbon cap. A carbon tax charges a given price for each unit of carbon, usually denoted in dollars per metric ton of CO_{2e}. This policy is frequently referred to as a tax, price, levy, or fee. In this case, the price is certain, but the emission reductions remain uncertain. This arises from the fact that we simply do not know how much emissions will be abated for a given price on carbon. If the price of carbon is \$230/tCO_{2e} we can estimate how much emissions will be reduced, but it's really just an educated guess.

While a carbon cap is by no means a silver bullet to the climate crisis, a well-designed carbon cap can bring sizable, lasting benefits to current and future generations, promote equity, and reclaim common ownership over our environment.

A carbon cap on the other hand sets a quantity of CO_{2e} emissions that can be emitted and sells emissions permits through an auction up to that cap, while allowing the price to vary. Here, we have emissions certainty but price uncertainty. Of course, we can also imagine a combination of the two, as has been implemented in Switzerland and was proposed in California (Fremstad and Paul 2017).

Provided that the point of the policy is to meet agreed upon climate goals and emissions targets, rather than to raise revenue, we prefer a carbon cap. This will ensure that emissions targets are met by allowing the price of emissions permits to fluctuate. It's important to note that many equate a carbon cap with a carbon cap-and-trade policy, however this need not be the case; permits may be time-limited and nontradable (Boyce 2018). Further details on policy design are discussed below.

Many economists have called for a carbon tax or a carbon cap to address our climate crisis. After all, we live in a market-based economy where many decisions are influenced by prices reflected in the market, despite the fact that the state plays a major role in creating and shaping markets. With current prices of fossil fuels far too low to reflect their true social cost, placing a price on carbon through a carbon tax or cap can play an important role in reducing GHG emissions. Currently, when you go to the pump and pay to fill up your car, you're not being charged for the damages associated with burning the fossil fuels. If policymakers were to implement a carbon cap, as we will discuss below, the price of gas, along with other goods and services in the economy, would increase in line with their carbon content (i.e., gas would get more expensive relative to, say, food, which is less carbon intensive). This would send price signals to firms, governments, and everyday people to consume less carbon-intensive goods and services.[16]

16 Over 46 national jurisdictions, as well as over 20 cities, states, and regions, have implemented a carbon pricing mechanism to date, with many more in the works (Carbon Pricing Leadership Coalition. n.d.). While California and nine northeast states (through the Regional Greenhouse Gas Initiative) have passed some form of a carbon price, the US as a whole has failed to pass a carbon price at the national level. The most famed effort to do so was the Waxman-Markey bill. For a deep dive into the failure to pass this bill, see *Naming the Problem: What it Will Take to Counter Extremism and Engage Americans in the Fight against Global Warming* (Skocpol 2013).

A carbon price is not a panacea. Recently, a group of eminent economists from both parties, including Nobel laureates and former Federal Reserve chairpersons, endorsed a carbon tax-and-dividend program as *the* solution to our environmental crisis (Baker et al. 2017). While we argue that a singular market tool is not enough—and a suite of policies, including public spending and environmental regulation, are available and necessary—it is worth noting that these economists supported the idea of a carbon dividend (i.e., a way to redistribute the revenue raised by a carbon tax or cap back to the people). Historically, economists have argued that the revenue raised from a carbon price should be used for tax cuts, while policymakers have often been keen on using the revenue for green investments; however, such revenue spending fails to protect the purchasing power of most Americans and would result in a sizable reduction in people's incomes (Fremstad and Paul 2019; Jorgenson et al. 2015; Goulder and Hafstead 2013). Instead, a dividend takes the revenue raised and gives it back to the people in an equal per-capita measure. In other words, if $500 billion is raised annually, and there are about 330 million people in the US, each would receive about $1,500 back every year. Those who emit more carbon than average would end up paying in more than they get back, while those who emit less carbon than average would end up paying in less than they get back. This is a vital aspect of building an equitable carbon price. While a carbon price, coupled with a dividend, would make it easier and more equitable to transition the economy, it is far from sufficient.

Though this is a policy prescription that economists across the political spectrum broadly support (Hook 2019; IGM 2012; Fremstad and Paul 2017), some environmentalists and climate advocates have been understandably skeptical of market-based policies (Edwards 2018; Huber 2016; Klein 2016; Walsh 2018). They critique the program on a number of grounds, including the ideas that a carbon price may be regressive, easily gamed by corporations, insufficient to address the climate crisis, and ignores the plight of communities that require environmental justice.

First, there's robust literature modeling the effects of a carbon price on inequality, and the results indicate that a carbon cap-and-dividend program would indeed be strongly progressive, redistributing revenue from the rich to the poor (Fremstad and Paul 2019). Second, domestic and international examples of carbon pricing legislation have often resulted in corporate giveaways; this, however, can be overcome through policy design that puts the interests of people before corporations. Third, we want to reiterate our belief that a carbon price (through either a tax or a cap) alone is insufficient to address our environmental disaster. A carbon cap should be considered as *one* of the policies comprising a comprehensive suite of legislation. Finally, we also share the concerns that a carbon cap fails to address the plight of environmental justice communities. These concerns, such as prioritizing emissions in sensitive areas and areas that have historically been disproportionately polluted, will require complementary policies to address, such as environmental regulations to eliminate harmful co-pollutants.[17]

Sample Policy

Rather than allowing polluters to emit into the environment for free, the federal government should implement a carbon cap-and-dividend program for GHG emissions across the entire US economy. In turn, the price of goods and services will increase depending on their carbon content. This is easiest to see at the gas station, where the price of gas will increase about $0.01 per gallon for every $1 per tCO_{2e}. But the price of other goods will increase too, so that goods more closely tied to carbon emissions (e.g., airplane tickets) increase in price more relative to goods with little carbon embedded in them (e.g., education).

17 Note that the policies contained in this report are sample policies and are not comprehensive. For instance, there is no policy included to address harmful co-pollutants, yet this should be a priority due to health and environmental justice concerns.

The economy will respond as relative prices change, with people, businesses, and governments adjusting their behavior to reduce their carbon footprint when possible. The point of a carbon cap is not to raise revenue or reduce the purchasing power of people but to incentivize economic actors to reduce emissions and transition to a clean and renewable economy.

A simple cap-and-dividend structure should be implemented, as it would best achieve the goals of pricing emissions along a path to meet agreed-upon emissions reductions. The carbon cap could be determined by a group of stakeholders, with a maximum emissions allowance that would reduce emissions at least in line with recent IPCC guidelines, though preferably faster.

To make the transition equitable, the revenue should be rebated through a carbon dividend. A carbon dividend would simply be a payout to all of us in equal per capita measure, meaning a carbon cap will help us meet our emissions targets while ensuring that the vast majority of low-income families come out ahead financially. Although everyone will receive a dividend, the policy will nevertheless benefit low-income people more (see graphics and example below). In order to protect those least able to deal with the financial effects, the first dividend can be pre-paid so that people do not have to wait for a rebate until months after paying the increased prices. This policy will promote equity by redistributing funds from high polluters, mainly the rich, to low polluters, mainly low-income households. This is crucial to successful climate policy and to ensure carbon pricing schemes are designed to take into account important distributional consequences.

To guide policymakers, we set out a number of policy guidelines for the carbon cap-and-dividend:

1. Price emissions upstream: To cover the maximum amount of GHG emissions while ensuring minimal compliance challenges, emissions should be taxed upstream, meaning at the wellhead, refinery, or mine. This policy design would allow the government to effectively cover the vast majority of fossil fuels while only monitoring 1,150-2,000 points across the US (CBO 2001; Metcalf and Weisback 2009).

2. Establish emissions targets: To fully take advantage of the carbon cap policy design, policymakers should adopt a clear emissions trajectory. This should be done with stakeholder involvement from environmental justice groups and affected communities. For instance, the emissions reductions should at least be in line with the recent IPCC guidelines to cut emissions by 45 percent by 2030 and reach net carbon neutral by 2050; however, provided that the US has emitted far more than its fair share historically and is one of the wealthiest countries, the emissions targets should be stricter, with a target of net carbon neutral by perhaps 2035 or 2040. Once the cap for a given year is set, the government should sell permits at an auction.

3. Recycle 100 percent of revenue to the public through a carbon dividend: Money raised through the carbon price should be rebated in equal per-capita dividends. This policy is critical to protect the purchasing power of low-income Americans and to build common ownership and buy-in pertaining to the environment. While a carbon price is regressive—disproportionately impacting the least well off in our society—a carbon dividend protects the purchasing power of a majority of people in the US and 84 percent of those in the bottom half of the income distribution (Fremstad and Paul 2019).[18] Further, the universal nature of the dividend is crucial to building across-the-board buy-in from political constituencies and for building common ownership and support for our natural assets. Like Medicare and Social Security, the universal nature of the program can make it politically durable (Barnes 2014; Boyce 2018).

4. Border-adjustment tax: Climate change is a global phenomenon, and we live in a global economy. To ensure that the US does not simply offshore carbon emissions, a border-adjustment tax is essential. This simply means that the government should levy a tax on carbon-intensive imported goods based on their carbon content.[19]

5. No permit trading and limited banking: With all permits allocated at auction, no trading is necessary; firms simply buy the permits they need at auction. Without trading, there is no scope for market speculation or profiteering (i.e., we are not in any way commodifying or financializing the environment).

6. No offsets or exemptions: To ensure that polluters actually pay for the emissions they create, the policy should be designed to eliminate any potential gaming of the system. This means no carbon offsets and no free allocation of permits.

To illustrate how such a proposal would affect the pocketbooks of Americans across the income distribution, Figure 3 provides an example assuming a $230 price per permit ($t/CO_{2e}$).[20] This number is based on a permit price associated with meeting 2.5°C of warming, according to Nordhaus (2017)—which is insufficient to meet our climate goals, but as we explain below, this is just one of many policies aimed at decarbonizing the US economy. Keep in mind that the price will be determined by the auction for permits, which will provide a fixed number of permits in line with our emissions goals. The analysis of the distribution below holds for alternative prices determined at auction, but the magnitudes of dollars redistributed will change.

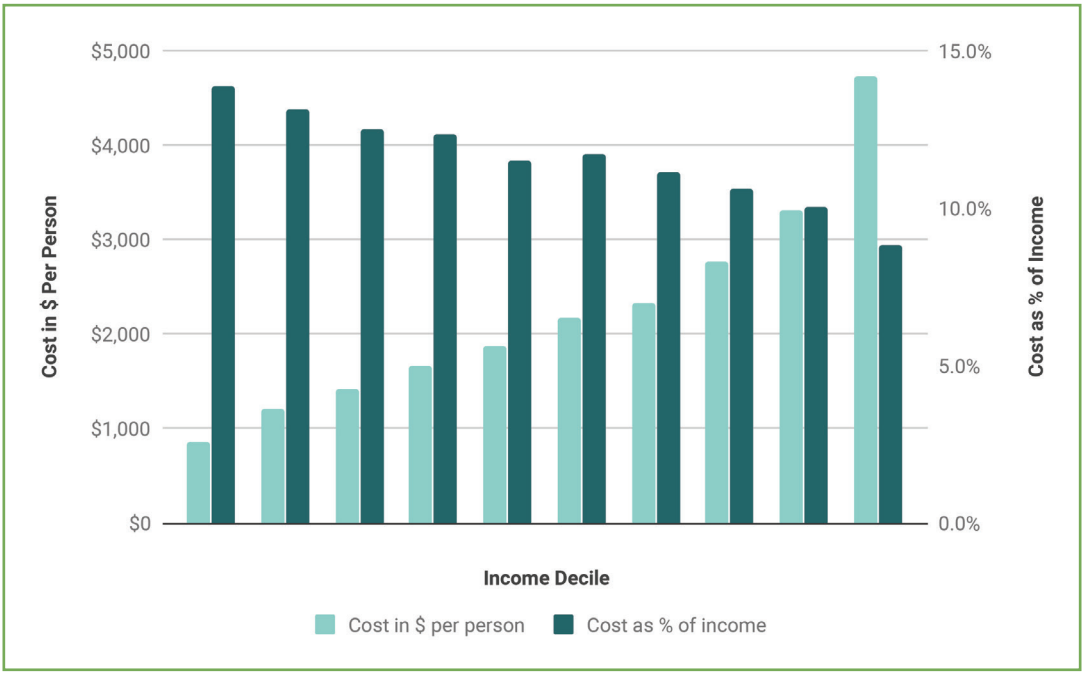
18 The program should "keep government whole." This would rebate the revenue back to the people who collectively paid into the program while rebating the revenue paid in by the government back to the government itself. This ensures the protection of local, state, and federal governments' purchasing power. The numbers provided above reflect this and are fully explained in Fremstad and Paul (2019).

19 From a justice perspective, some argue that low-income countries with a minimal historic record of emissions should be exempt from such a tax. For more, on this, see Beachy (2016).

20 For a more in-depth discussion of a carbon price-and-dividend, see Fremstad and Paul (2018).

FIGURE 3:

Carbon Tax Burden

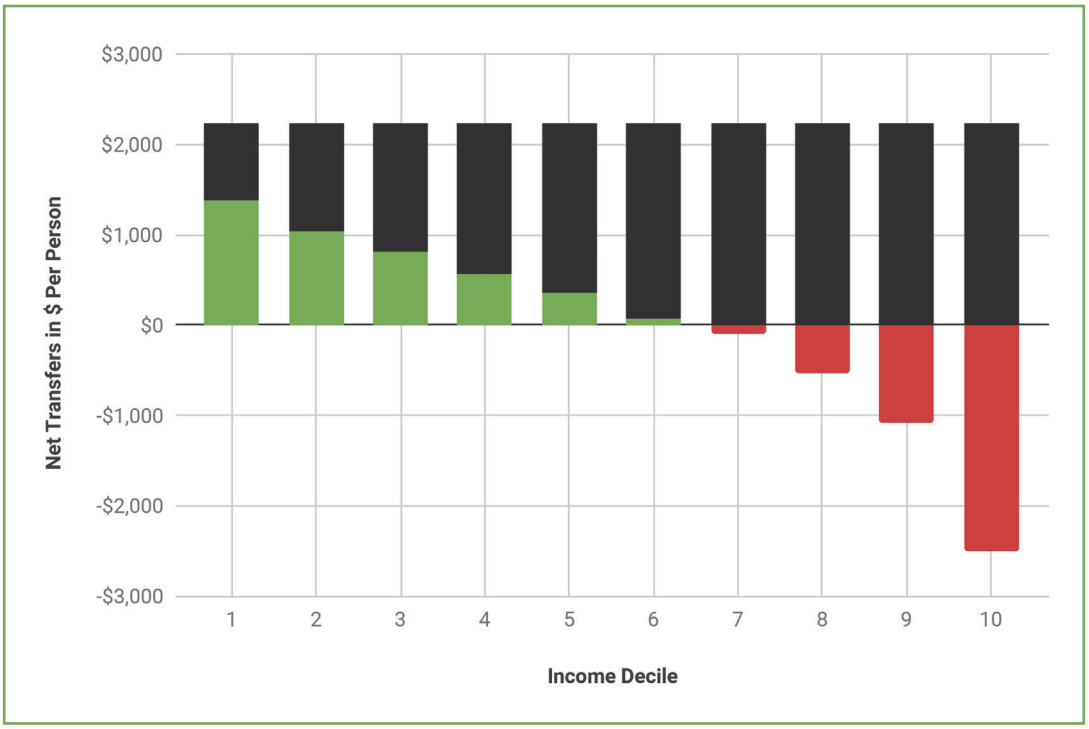


The light blue lines show the cost per person in dollars of a $230 carbon price that is implemented economy-wide. This demonstrates that high-income people pay more in absolute dollar terms than low-income people do. The dark teal line, however, shows that a carbon price is initially regressive since the carbon price affects a larger percentage of low-income people's income.

Figure 3 demonstrates the initial burden of the carbon cap—the incidence of the tax before the money raised is redistributed—at a price of $230 per permit. Under such a carbon cap, the poorest 10 percent of people will pay in just under $1,000 per person per year through higher prices in the economy, while the richest decile will pay almost $5,000 per person per year. Despite the fact that the rich pay significantly more because they pollute much more, the initial tax is still regressive. This is due to the fact that for the poorest decile, the tax represents about 14 percent of their income, while for the richest decile the tax only represents 8.8 percent of their income; however, this can be remedied through an equal per-capita carbon dividend to everyone in the US.

FIGURE 4:

Net Transfers Under Carbon Dividend



This chart demonstrates that equal per-capita dividends can make an initially regressive carbon price progressive, protecting the incomes of the low-income people across the country.

Figure 4 demonstrates the net effect on one's pocketbook of a carbon dividend. The black bars represent the fact that everyone will receive the same annual carbon dividend of just over $2,200.[21] The green bars represent the net benefit to groups that come out ahead. We see that the bottom 60 percent of households come out ahead on average, while the richest 40 percent end up paying more in higher prices than they get back through the carbon dividend. In other work, we also demonstrate that the majority of communities of color come out ahead under a carbon dividend policy such as the one proposed here (Paul and Fremstad 2019).

Pricing carbon and returning the money to the people in equal dividends, similar to the idea behind the Alaska Permanent Fund—an idea implemented by a Republican governor and supported across the state's political spectrum—is a critical tool to rapidly curtail the use of fossil fuels and speed investments in clean energy technologies and energy efficiency upgrades. The prices have been wrong for far too long. It's time to get them right.

21 Carbon dividends could be paid out quarterly to ensure that households do not have to wait a full year during which they're paying a higher price but are not being protected. The government could also pre-fund the first dividend to ensure low-income households are initially protected against an increase in prices.

1.2 Building the Carbon-Neutral Economy

Retrofit Existing Buildings

Summary

Buildings currently account for 39 percent of US GHG emissions (EIA 2018b), so policymakers must make their decarbonization a crucial part of meeting emissions targets. To address energy challenges presented by the existing building stock, the US should retrofit all buildings through a combination of financial incentives and mandates. This would entail fully electrifying buildings and improving energy efficiency. Together, these two policy choices will allow for the decarbonization of the existing building stock.

Background

Retrofitting the existing building inventory in the US is a sizable undertaking. Currently, there are an estimated 5.6 million commercial buildings and 118 million housing units, many of which are outdated and inefficient, yet will remain in use for decades to come (EIA 2016; EIA 2018). Upgrading the existing building stock and making it carbon neutral will require two primary components: First, buildings have to be fully electrified; second, buildings need to be retrofitted for energy efficiency to reduce energy use. Retrofitting buildings already in place could create a win-win-win scenario by providing lower long-term operating costs, reducing GHG emissions, and creating millions of jobs across the US.

Emissions from buildings can be split between direct building emissions, which are emissions due to the combustion of fossil fuels, and indirect emissions, which are emissions from electricity consumption. One quarter of building emissions can be attributed to their direct energy consumption and three quarters to indirect energy consumption (DOE 2017). Electrifying buildings would address the problem of direct emissions by requiring the replacement of existing fossil fuel-based systems for heating, drying, and cooking across the residential and commercial sectors (Jacobson et al. 2015). This would simply put an end to fossil fuel use in buildings, rendering the existing fossil fuel infrastructure for the residential and commercial sectors of the economy obsolete.

Energy efficiency (EE)—using less energy to provide the same service—is one of the most direct and cost-effective ways to combat climate change.[22] Energy-efficiency retrofits for existing buildings include upgrading insulations, windows, lighting, and appliances to energy efficient models, as well as other improvements to reduce energy use.[23] An investment at $2,500 in energy-efficiency retrofits for dwellings can reduce energy consumption by 30 percent, providing enduring benefits for the climate and those paying the utility bills (Pollin et al. 2014). However, given the fact that 40 percent of Americans can't afford a $400 emergency expense, financing such investments will simply be out of reach for far too many people (Federal Reserve Board 2018). Investments in building retrofits also produce jobs, creating an estimated seven direct jobs and five indirect jobs for each $1 million in spending (Pollin et al. 2014).

22 While energy efficiency will help reduce electricity demand, policymakers are increasingly talking about policies to target emissions efficiency, which are broader and would also encompass electrification of the building sector. Emissions efficiency reflects fewer emissions created per unit of useful output of an energy-consuming service (Dennis et al. 2016). As an example, we can think of the amount of CO2 emitted to heat a home. First, it would have to be electrified, and then there would have to be energy-efficiency upgrades to continuously improve electric heaters such as heat pumps.

23 While it is beyond the scope of this subsection, policymakers should also develop policies that include continuous improvements for appliances, home electronics, and building materials to ensure that product development continues to improve energy efficiency.

These improvements can have important implications for equity, as utility bills fall disproportionately on disadvantaged communities, which are also more likely to live in inadequate housing stock, have older appliances, poor insulation, and inefficient heating, cooling, and lighting systems. Well-designed public policies such as building retrofits can thus have important distributional effects.

While there is currently no comprehensive national plan to retrofit the existing building stock, there is much that can be learned from existing state and city programs. The five top-rated states for energy-efficiency policy are currently Massachusetts, California, Rhode Island, Vermont, and Connecticut (Berg et al. 2018). To date, these states have run programs to assist their residents and businesses in retrofitting the existing building stock, which has resulted in reduced emissions, better air quality, and significant savings for homeowners, renters, and business owners. In Massachusetts for instance, the Mass Save initiative saved almost 3 million metric tons of CO_{2e} through 2015. Overall, the fully funded 2016-2018 electric and natural gas efficiency plans yielded over $9 billion in economic benefits. The state estimates that through the program, it has generated $4.17 in benefits to homeowners and $5.10 for businesses per dollar invested (Chu et al. 2019; Mass Save 2016).

California expects to achieve a cumulative doubling of statewide energy-efficiency savings in electricity final end uses of retail customers by January 1, 2030, as a result of the groundbreaking 2015 climate legislation SB 350. Like Massachusetts, the state is working to direct investments to low-income communities, as recently seen by the approval of $50 million of investments in clean, all-electric buildings for low-income residents in the San Joaquin Valley (Golden 2018). Overall, the state has committed to reducing building sector emissions by 40 percent below 1990 levels by 2030 through AB-3232 (2018). Cities like New York City and Washington, DC, are also implementing programs for energy-efficiency investments due to continued federal inaction (Roberts 2019).

Though estimates vary, most suggest that the payoff period for building retrofits are short, spanning just 3-5 years in some cases (Pollin et al. 2014). A major McKinsey report on energy efficiency found that a $520 billion investment in energy-efficiency programs nationwide would gross energy savings worth over $1.2 trillion, and that's not even taking into account the climate or health benefits (Choi Granade 2009).[24] Even research that suggests that the actual energy savings are just one third of those implied by engineering models, energy-efficiency investments still pay off in a reasonable timeframe if emissions are valued at roughly $200 per ton of CO_{2e} (Fowlie et al. 2018).

Sample Policy

To decarbonize the existing building stock in the US, Congress should establish and fund a new federal program to oversee and manage the process of retrofitting the existing building stock. The program should immediately begin retrofitting all public buildings across scales of government. This program will work at the national, regional, and local levels to fund electrification and energy-efficiency improvements of existing buildings, bringing an important inflow of funds and jobs to localities across the US. The program should electrify and upgrade all government buildings in use by 2030. Notably, the policy should first prioritize the network of schools across the country. With an estimated 98,000 public schools in the US (NCES 2018), retrofitting could provide both local employment opportunities and much-needed savings for underfunded local school districts by significantly reducing their utility bills.

24 Such findings sometimes lead policymakers to ask why homeowners need the government to assist in facilitating building retrofits if the return on investment pays off. It is important to note that there is an important role for government to play due to a number of reasons, including imperfect information, loan market inefficiency, and general lack of resources.

The program should also be tasked with assisting in the retrofitting of the private building stock in the US. The government should fully fund and prioritize initiatives that retrofit the homes of low-income homeowners and renters across the country. For the rest of homeowners, the government should provide a robust cost-sharing program that matches homeowners' expenditures to fully electrify and upgrade the energy efficiency of their homes. None of these funds should be used to subsidize any fossil fuel devices in buildings. Additionally, the government should pass mandates to end the sale of fossil fuel devices for buildings by 2025. To assist homeowners with the remainder of the investments needed, the government should provide no- or low-cost retrofit loans.

Require New Buildings to be Carbon Neutral

Summary

Meeting emissions goals requires that new buildings are carbon neutral. To meet this goal, we propose that by 2025, all new buildings should meet high energy-efficiency standards, rely entirely on electric power, and be accessible by public and other forms of carbon-free transportation. This can be accomplished through new building regulations that are implemented immediately and ramped up fully by 2025.

Background

A carbon-neutral economy requires a fundamental transformation of the built environment. US buildings tend to be energy inefficient and dependent on fossil fuels and car-based transportation.
The building sector is an example of an area rampant with market failure due to incomplete contracts, as the incentives among builders who actually build new houses and offices and the people who live and work in them are poorly aligned. Developers and landlords rarely pay to operate buildings, including electricity bills. Thus, they tend to under invest in constructing energy-efficient projects to reduce emissions (Gerarden et al. 2017). For these reasons, setting a carbon price will have a limited impact on building emissions, and thus carbon-neutral building regulations are an integral component of decarbonizing the economy.

One way the US has attempted to improve new building efficiency is to improve incentives. This includes providing builders with voluntary certifications, such as the EPA's Energy Star program and the nonprofit US Green Building Council's Leadership in Energy and Environmental Design (LEED). While energy-efficient buildings have upfront costs, they also have long-term benefits, since energy costs make up a substantial portion of the operating cost of buildings. A recent report by the Rocky Mountain Institute found that the payback period for net-zero energy homes is less than 14 years in most of the 50 largest US cities, with some cities experiencing a far shorter payback period (Petersen et al. 2019).

Certifications help developers recoup their investment. Today, approximately 40 percent of new office space in the US is certified by Energy Star or LEED (National Green Building Adoption Index 2017). Research shows that buildings with an Energy Star or LEED certification consistently rent for about 7 percent more than non-certified buildings. Moreover, this benefit is capitalized into asset values, so that certified buildings are worth roughly 13 percent more than their counterparts (Eichholtz et al. 2013). Eichholtz et al. (2013) conclude that: "These results suggest that more aggressive policies—in the United States and elsewhere—of certifying, rating, and publicizing buildings along these dimensions (including, perhaps, buildings that score well on measures of energy efficiency) can have a large payoff in affecting energy use and maybe the course of global warming."

Most states have some type of building energy code (Abergel et al. 2018), but these regulations must be made more stringent and universal to meet emission targets. For best practices, we can look at California, which is currently leading the way in the US. In 2015, California adopted a New Residential Zero Net Energy (ZNE) Action Plan (CA Energy Commission and CA Public Utilities Commission 2015). This created a *voluntary* program for ZNE homes through 2019 and mandated that all new homes be ZNE by 2020.

To reach this goal, California is also requiring most new homes to have solar panels by 2020. This is expected to raise the cost of the average home by about $10,000, yet the upgrade will save households approximately $20,000 in electricity bills over the typical 30-year mortgage timeframe. Although rooftop solar is a relatively expensive form of carbon mitigation, this math is likely to improve over time, and already the benefits significantly outweigh the upfront costs. For instance, rooftop solar installation in the US is substantially more expensive than in other countries, but large-scale deployment efforts will help drive down costs, making carbon-neutral buildings cheaper (Trabish 2018).

New developments should also tie into green mobility infrastructure by connecting residents to mass transportation and investing in sidewalks and bike paths that make cities and suburbs more walkable and bikeable. Such a program represents a new level of investment in buildings that may modestly raise the price of new construction, but it will have enduring benefits to building operators, local communities, and the environment at large (Athalye et al. 2016).

Sample Policy

The US government should tighten building codes for new buildings. This can build on the existing models of national building codes, which allow for flexibility in building standards to account for variation across climate zones (DOE 2018). By 2025, it should be mandatory for all new buildings to meet high energy-efficiency standards, rely entirely on electric power, and be accessible to green mobility infrastructure.[25] To meet these standards, the US must stop installing fossil fuel furnaces, water heaters, and appliances in new buildings.[26] The program should start immediately and gradually ramp up to the full standards in 2025. From there, the program should have standards that automatically tighten as new building materials become scalable, thus continuing the innovation process into the future.

Expand Mass Transit

Summary

Currently, the transportation sector is responsible for 28 percent of total GHG emissions, making it a top priority for policymakers (Lawrence Livermore National Lab n.d.). We recommend a major expansion of investments in mass transit across the US. The aim is to increase ridership and electrify existing transit systems while building out new forms of public carbon-free mass transit to underserved areas. Additionally, the US should make public transit free to incentivize ridership and eliminate fares that disproportionately burden low-income people.

25 While all urban and suburban new construction should be accessible to green mobility infrastructure, we recognize that this is unlikely to be the case for rural construction. To this end, the access-to-infrastructure requirement should not be applied in rural areas.

26 While new furnaces, water heaters, and appliances should be electric, the government should also put in place complementary appliance standard requirements. For instance, the US GOA estimates that failing to update appliance standards in the US in the 1990s and early 2000s will cost consumers at least $28B through 2030 (GAO 2007). Improving the EE versions of all of these is critical to meeting emission targets in a timely manner. Importantly, history has many examples of appliances, such as refrigerators, that became both cheaper and more efficient while also increasing in actual size (DOE 2011).

Background

Humans are an "infrastructure species" (Britton- Purdy 2018), and our existing transportation infrastructure is built for fossil fuels and private vehicles, both of which contribute to the climate crisis. Our existing car-based infrastructure is expensive, regressive, causes major health problems, and limits our ability to build community. Further, the current transportation system is extremely carbon intensive. The average household consumes over 1,100 gallons of gasoline a year, largely driven by car-based commuting (EIA 2017). Other modes of transportation are far more efficient: On average, subways produce 76 percent lower GHG emissions per passenger mile than the average single-occupancy vehicle, while light rail systems produce 62 percent less, and bus transit produces 33 percent less (DOT 2010).[27] If ridership on these services can be increased and they were to be electrified, emissions per passenger would be even lower.

Beyond being dirty, our current transportation system is enormously expensive. State and local governments spend $200 billion annually on highways and roads (DOT 2018). However, most of the cost of our current transportation system falls on US households. Americans collectively spend $1.1 trillion each year to purchase, operate, and maintain their vehicles (DOT 2018). This amounts to the average household spending over $9,000 a year on private vehicles (ibid.); yet, these privately owned vehicles are actually *in use* only 4 percent of the time (Santos et al. 2011).

The current transportation system, which relies primarily on private vehicles and chronically underfunded and underbuilt public transit, not only contributes to a dirty and expensive system but also represents profound challenges for many low-income households across the US that cannot afford private vehicles or access affordable and reliable transit. Without access to safe, affordable, and reliable transportation, many low- and middle-income people are excluded from employment opportunities outside of their immediate vicinity. Often, low-income people are forced to live in economically depressed areas of cities and counties due to high housing costs, far away from job prospects. The low-income parts of cities are also frequently the last to see investment in public transportation, further marginalizing these communities and excluding them from economic opportunities. This disproportionately burdens low-income households and exacerbates economic inequality through a number of mechanisms, including increasing frequency and duration of unemployment (Stacy et al. 2019).

Investments in green public transportation can revitalize our crumbling public transit systems, sharply reduce our reliance on private vehicles, and move us toward a more equitable and carbon-neutral economy. A report by the University of California Davis and the Institute for Transportation Development Policy estimates that, in conjunction with policies to adopt EVs, green transportation that facilitates trip sharing, public transportation, cycling, and walking would both reduce transportation emissions by 80 percent and *cost less* than business as usual (Fulton et al. 2017). If investments were made in an equitable fashion, these investments would also disproportionately benefit low-income communities in many of America's cities and suburbs. Complementary policies, such as ones that increase the average occupancy of public transportation (e.g., by making it free), would generate even larger emission reductions and efficiency gains. Additionally, policies to reduce green transportation would deliver enormous health benefits, as air pollution from vehicle emissions causes 58,000 premature deaths annually (Caiazzo et al. 2013).

27 When life cycle emissions are taken into account, researchers find that public transit is even more efficient in terms of emissions per mile (Chester and Horvath, 2009).

The federal government currently devotes just $11 billion annually to mass transit (DOT 2018) and $1 billion to pedestrian and cycling infrastructure (Pedroso 2017). This level of funding is woefully insufficient to maintain the existing transit systems, let alone upgrade existing systems to be carbon neutral while building out new transit systems to greatly expand carbon-free transportation options and reduce reliance on private vehicles.

Provided that mass transportation is a public good, and that state and local governments face serious fiscal constraints that limit their ability to borrow, constraints which can be overcome at the national level thanks to additional sources of revenue and debt instruments, the majority of funding should be undertaken by the federal government. While the scale of investment required to massively build out carbon-neutral mass transit has not been seen for decades, rebuilding the country's infrastructure is a task that has achieved bipartisan support in the past, as exemplified by President Dwight Eisenhower's establishment of the US interstate highway system. Though green public transportation should be largely funded by the federal government, the exact type of infrastructure should be determined by each locality to meet their specific needs. Expanding and improving metro lines may be an appropriate pathway in places like New York City, but cities without metro systems may instead need to invest in light rail or bus rapid transit systems, which can be 90 percent cheaper than underground subways (Margolis 2015). For towns, small cities, and the outskirts of medium cities, urban electric bus systems would likely provide the best solution.

Investments in green transportation will complement other policies for a Green New Deal. While policies such as a carbon dividend will increase demand for carbon-free transportation, they do not automatically supply people with functional alternatives to go about their daily life. To build a carbon-free transportation system, policymakers need to make mass transit, cycling, and walking preferable to personal car use. Investing in green transportation policies will have many benefits, including reducing carbon emissions and co-pollutants, improving public health, increasing mobility, and allowing for greater density to combat our housing affordability issues. The key to achieving these benefits is to ensure that all residents have access to a variety of attractive, affordable, and safe forms of transportation that make decarbonized transit the *best available option*.

Sample Policy

The US government should rapidly increase investment in carbon-free public transit, bicycle lanes, and sidewalks across the US. Importantly, to increase utilization and build a more equitable transportation system, public transit services should be made free.[28]

To meet these goals, federal funding for green transportation should be rapidly increased to enable mass transit systems in order to phase out rider fares, which currently collect $18 billion (American Public Transit Association 2018); fully electrify the system; and massively expand capacity in order to increase access to public transportation. This should include funding upgrades to existing transit systems as well as investments to build new transit systems in underserved areas. Additionally, federal funding for cycling and pedestrian infrastructure should also be immensely increased.

28 Fare-free public transportation is already available in 98 cities and towns around the world (Keblowski 2018).

Electrify the Vehicle Fleet

Summary

To electrify the vehicle fleet, the US should implement policies to replace vehicles powered by internal combustion engines with modern electric vehicles (EVs). The US can do this by extending the existing electric vehicle tax credit and making it a rebate, so that low-income individuals will benefit as well. Additionally, the US should mandate that automobile companies increase the share of electric vehicles sold each year, with the requirement that 100 percent of new car and truck sales are EVs by 2030.

Background

Eliminating carbon emissions from transportation, which accounts for 28 percent of emissions, can be achieved by a broad array of mobility policies that shift people from driving to walking, biking, and mass transit; however, an estimated 80 percent of current trips are currently made by driving a car, making the electrification of vehicles a top priority (DOE, FHA 2017). Together, cars and trucks are responsible for 83 percent of the transportation sector's total emissions, making them a major contributor of GHG emissions (EPA 2018). EVs are quiet, scalable, require little maintenance, and most importantly generate no tailpipe emissions. To rapidly decarbonize the transportation industry, the economy must rapidly transition to a future comprised of EVs.

The US government has been working to reduce emissions from vehicles for decades, largely through the use of the Corporate Average Fuel Economy (CAFE) standards. The US introduced these standards in 1975 and cut new vehicles' CO2 emissions per mile by 40 percent in just 10 years (EPA 2018). Unfortunately, this dramatic progress was followed by 25 years of inaction. In 2010, US vehicles emitted more carbon per mile than those in many other countries, including Brazil, Canada, India, Japan, Mexico, South Korea, and in the European Union. Under President Barack Obama, the EPA tightened emission standards; even if they are fully implemented, however, American vehicles will still emit 25 percent more than European vehicles in 2025 (International Council on Clean Transportation 2019).

When they were initially introduced, EVs faced a number of problems, including high costs, limited driving range, and insufficient charging infrastructure. This is despite the fact that electric motors are significantly more efficient than combustion engines: EVs convert about 60 percent of electric energy into motion, while traditional automobiles convert just 20 percent of the energy stored in gasoline into motion (Department of Energy 2019). To address these issues, the US has worked to subsidize the development and adoption of EVs. Unlike rampant subsidization for the fossil fuel industry, this is an example of the virtues of nudges within markets working in favor of decarbonization

To date, government incentives in the form of tax credits have helped bring down EV costs; however, these tax credits are unfortunately being phased out. The electric vehicle tax credit, passed in 2009, provides a tax credit up to $7,500 for electric vehicles; however, it phases out once a manufacturer delivers 200,000 electric vehicles (Tesla and GM are already being phased out). While battery costs for EVs are declining 15-20 percent per year, additional subsidies will help deploy more EVs, which will in turn help drive down the cost of EVs and make them more competitive by helping to increase their market share (JP Morgan 2018). Analysts believe that EVs will reach cost parity with combustion engine counterparts by 2020-2029, and some EV models have already reached cost parity on a total cost of ownership basis (JP Morgan 2018; McKerracher 2018).

In terms of the performance of EVs, we have seen massive improvements in vehicle range, with many EVs getting 250-300 miles per charge, making vehicle range a non-issue for most consumers. Another key issue, which remains a challenge, is vehicle charging. Unlike our extensive network of gas stations, the US does not have a national or even regional charging infrastructure network. Charging can take place in four key spaces: home, work, in public (such as parking spaces in cities), or on highways for long-distance trips. While 80-90 percent of charging is done at home or work for those who have access to charging at their workplaces, a lack of charging infrastructure remains a significant challenge. To date, fast-charging infrastructure has been lagging, largely due to a failure of large-scale public investment, including policies that seek to coordinate the private investment needed. We have seen a large uptick in the buildout of new charging stations across the US, and there is good reason to believe that this network will look very different than the current network of gas stations to service internal combustion engines—though this infrastructure remains underdeveloped (Engel et al. 2018).

The transition to EVs will take time. Since the average vehicle runs for 11 years, internal combustion engines sold today will still be on the road in 2030. Thus, policymakers must quickly increase the market share of new EVs leading up to 2030. Countries that are committed to preserving a habitable planet have established ambitious goals: Norway, for example, has adopted a variety of policies to make EVs 100 percent of all new passenger vehicle sales by 2025 (Norwegian Transport Agencies 2016).

Sample Policy

To electrify the vehicle fleet, the United States should use both financial incentives and mandates to foster a rapid and equitable transition. First, the US should eliminate the cap and phase out of existing EV tax credits (up to $7,500 per vehicle), which is currently triggered after the delivery of 200,000 EVs by an automaker and until the full transition to EVs has occurred. The full $7,500 tax credit should also be changed to a rebate, which customers can receive at the time of purchase. This will help ensure that EVs are accessible to low-income households who many not be able to take advantage of the EV tax credit in a single year and can't afford to wait for tax season.

While the US should continue to tighten fuel economy standards over the next decade, an EV mandate is necessary for the US to decarbonize the transportation sector. To meet emissions targets, the US should implement a federal EV mandate beginning as soon as possible, ramping up over time so that EVs represent 100 percent of new vehicle sales by 2030. This regulation harnesses economies of scale to reduce the cost of purchasing, running, and maintaining an EV. Complementary policies will also be needed to decarbonize transportation. Above, we talked about mass transit investments to drive down the demand for private cars; additionally, to ensure that EVs reduce emissions, the government will have to rapidly shift electricity generation to clean and renewable energy. Public investment in EV infrastructure, especially charging stations, will also complement the EV incentive and mandate.

Build a High-Capacity National Grid

Summary

As the economy transitions toward carbon neutrality, the electricity sector must be fully transitioned to clean and renewable energy sources. The US currently lacks a comprehensive national grid, and the grids that do exist are outdated and poorly designed to transport large amounts of renewable energy across long distances. This is a major obstacle to a 100 percent shift to renewables, since major renewable sources—wind and solar—are intermittent, or more available at some times rather than others.

The intermittency problem is made much worse by the limits on long-distance energy transmission—when renewables in one region fall short of meeting its needs, the existing grid cannot easily transfer energy from long distances. Decarbonizing the electricity sector will require significant improvements in long-distance energy transmission. In this subsection we propose building out a high-capacity national grid to address the intermittency problem.

Background

The electricity sector currently contributes 28 percent of US GHG emissions, putting it just behind the transportation sector as the largest emitter (EIA 2019a). To decarbonize the economy, emissions in the sector will have to be rapidly drawn down to zero as the grid transitions from a mix of fossil fuels (63.5 percent), nuclear (19.3 percent), hydro (7 percent), and renewables (10.2 percent) to all clean and renewable energy as soon as possible (EIA 2019a).

Perhaps the largest obstacle to fully decarbonizing electricity generation is not generation itself, but the grid. Renewable electricity is already cost-competitive with fossil fuels; coal-fired plants continue to be decommissioned, while solar and wind capacity is rising rapidly. The fundamental problem is not building up renewable capacity, but intermittency: wind and solar power generation depends on weather conditions. And electricity, unlike most other commodities, cannot be easily stored at industrial scales — it must be generated when it is used. This would not be a great problem if we had a genuinely national or, better, global grid—the wind is always blowing, and the sun is always shining, somewhere. But in the US, long-distance transmission is quite limited. New York City, for example, must meet 80 percent of its electricity needs from power generated within the city itself (Walawalkar, Apt, and Mancini 2007)

As long as electricity can neither be economically stored nor transmitted across long distances, there is a limit to the share that can be provided by renewables. There must be "dispatchable" power, which can be ramped up or down at short notice, to meet demand when renewable sources are offline. In practice this means fossil fuels, primarily natural gas with some form of carbon capture. Some fossil fuel plant may operate just a few days a year, at moments of peak demand.

In the long run, improved storage technologies may resolve the intermittency problem. These technologies, however, are just starting to be deployed at large scale. Improved transmission, on the other hand, is technologically straightforward; it simply requires investment to greatly raise the capacity of the existing grid and integrate it nationally (and eventually internationally). At a national scale, wind patterns are negatively correlated, meaning when the wind blows in one area, winds tends to die down in another. Similarly, the sun rises a few hours earlier on the east coast while it sets a few hours later on the west coast. Integrating the national grid greatly reduces the chance of major mismatches between power demand and renewable supply (Mills and Wiser 2010). This currently requires an available source of dispatchable (usually fossil-fuel) power.

Building a national grid that allows for energy to move across long distances could drastically cut carbon emissions while also saving consumers money, but it will require federal action (MacDonald et al. 2016). There have been proposals for a true national grid for decades. But as renewables' share of capacity grows steadily, the need for this new infrastructure is ever more pressing (NREL 2017; Friedlander 1968; Abraham 2002). Only a national grid can allow renewable energy sources to move toward 100 percent in a timely manner without the need for back-up fossil fuel plants for dispatchable power.

While the existing utility sector is well aware of the benefits of a national grid, they have failed to build a national grid for a number of reasons. Perhaps the fundamental obstacle is the coordination it would require across states and various utility companies (Roberts 2018). Siting the project has proven to be incredibly challenging, as has deciding who will foot the bill. The federal government is the only entity that could plausibly overcome these coordination problems. Similar examples can be found in other countries, such as China, which is already moving ahead with the buildout of a national power grid, demonstrating that the primary hurdle is not technological (*The Economist* 2017).

Building a national grid that allows for energy to move across long distances could drastically cut carbon emissions while also saving consumers money, but it will require federal action.

Other reforms to the electricity sector should be considered by policymakers. For instance, the current utility model is woefully outdated and currently structured to oppose the buildout of renewable energy and the decentralization of the grid. This model, which arose as a grand bargain, created a business model in which utilities largely operate as state-protected and state-regulated monopolies. Most of these monopolies operate within a cost-of-service-rate (COSR) model, which was designed to primarily run on fossil fuels. COSR requires utilities to sell power to ratepayers without a markup, and profits for utilities arise from their capital investments (i.e., building more energy infrastructure). While this model was effective in the 1930s, when incentives were needed to rapidly build out infrastructure to provide electrification across the country, COSR is poorly designed to motivate utilities to serve customer demands for renewables and facilitate a transition away from the current fossil fuel economy due to the problem of stranded assets—replacing existing profitable fossil fuel infrastructure—and stagnant electricity demand (Aas and O'Boyle 2016). One possible solution is for the public sector to take control of electric utilities. Running these in a truly democratic fashion would help meet our climate goals, achieve climate justice, and better serve everyday customers (Alperovitz and Bozuwa 2019; Koeppel et al. 2019).

Sample Policy

While the full decarbonization of electricity generation will require a variety of policies, such as a carbon cap-and-dividend and renewable electricity standards, the construction of a high-capacity national grid is a key part of achieving rapid decarbonization of the power sector. The federal government should undertake the funding and siting of a national grid that utilizes long-distance, high-capacity DC power lines to connect the US.

The US government should rapidly invest the estimated $70-80 billion required for new, high-capacity, long-distance power lines (Bloom 2018). The government should also be responsible for assisting in the coordination of transition line placement across state lines, perhaps simply following the interstate highway system.

Pay Farmers to Capture Carbon

Summary

While farmers are and will be deeply impacted by global warming, our industrial agricultural sector is also a key producer of GHG, responsible for 9 percent of US emissions. Yet farmers also hold enormous potential to curb GHG emissions. To support rural livelihoods on the farm and start the transition in agriculture from a net producer of emissions to net carbon neutral, or perhaps even a net carbon sink, the federal government should directly pay farmers to capture carbon in their soil—a vital ecological service.

Background

The industrial agricultural sector is a core contributor to GHG emissions. The EPA reports that 9 percent of all US GHG emissions come from this industry, particularly from factory-farm livestock. This likely underestimates the problem, as new research suggests that methane emissions are more problematic than conventionally thought (Ackerman 2019). The methane produced by cows, called "enteric fermentation," alone comprises almost a third of all emissions from the entire agricultural industry. In addition, the way that animal waste is stored and processed, the farm management of agricultural soils, and even the production of rice emits methane and/or nitrous dioxide—both potent greenhouse gasses (EPA 2019).

At the same time, farmers and rural communities are on the frontlines of climate change. Experts predict climate change to have profound effects on the agricultural industry. The increased presence of carbon dioxide levels, combined with changes in air temperatures and precipitation (droughts and flooding), will greatly intensify the uncertainty and economic instability that farmers and farm workers already face. Additionally, this places the food supply at enormous risk. Scientists suggest that climate change could have significant effects on crop yields as well as reduce the nutritional value of many food crops overall (EPA 2019).

These impacts on the farming industry will also have broader impacts on rural communities, which are economically dependent in a variety of ways on the natural resources that will be affected by climate change, especially through farming. Climate change will likely shift the ideal climate for various crops northward, which could hobble rural economies, especially in the south.

Climate change and its effects on farmers are situated in the context of agricultural communities that have already struggled economically for decades. Many family farmers are losing money—with many being swallowed up by factory farming—and those who remain are contractually dependent on agricultural conglomerates that have outsized control of the prices they pay and effectively become contract workers with less and less control over their growing practices, not to mention their income (Howard 2016). This current state of agricultural markets makes the burden that climate change places on farmers, and encouraging farmers to be part of the solution, that much harder.

In order to both reduce emissions from agriculture and enhance its potential to sequester carbon, the US will need to broadly reform the sector. For example, the US must improve regulation of the agriculture sector—both through the Farm Bill and beyond it—including shifting regulations to align with climate goals by, for example, regulating feedlot emissions (McGinn et al. 2016). Policymakers could also reform crop insurance markets, which are partly subsidized by the government, to incentivize sustainable practices by rewarding them with lower rates and better coverage (Lilliston 2018).

The sample policy we focus on here is a federal investment program in the vast capacity of farmers to sequester carbon by paying farmers to capture carbon in their soil. Responsible soil management holds enormous potential for capturing carbon from the atmosphere. Scientists are finding that farming systems that involve "integrated" soil-based practices—such as adequate crop rotation combined with minimal or no-chemical fertilizer and pesticide use—build organic matter in the soil that then promotes carbon accumulation in the ground. In other words, farming practices that are already better for productivity, environmental quality, and food safety are also a powerful carbon mitigation technique. Multiple studies demonstrate that agriculture's global sequestration potential lies in carbon capture through soil management (Zomer et al. 2017). And a study of the regional potential of carbon storage worldwide finds that North America has the highest potential for soil carbon sequestration, opening up a major opportunity to revitalize farming communities in the fight against climate change (Zomer et al. 2017).

As the idea of soil carbonization takes hold, some impractically propose paying farmers through a market that gives them credit for the specific amount of carbon they sequester; companies can then buy those credits to offset their emissions. Soil-carbon levels vary a great deal across even one acre of land, making measurement impossible (Gewin 2019). However, this approach would also create a carbon market and open the door to carbon offset credits, which have largely been a disaster and are strongly opposed by environmental justice groups. We argue for a simpler, more effective approach below.

In other words, farming practices that are already better for productivity, environmental quality, and food safety are also a powerful carbon mitigation technique.

Some states are taking matters into their own hands. For example, California has implemented the California Healthy Soils Initiative. With revenue generated through the state's cap-and-trade initiative, the state is piloting a program to provide grants up to $50,000 each to approximately 50 farmers to engage in sustainable practices, such as applying compost and mulch, planting cover crops, introducing natural windbreaks, reintroducing native plants, and creating silvopasture (which integrates trees with pasture). These methods not only pull carbon from the atmosphere but also enhance farm productivity by building topsoil fertility; reducing the need for chemical pesticides, herbicides, and fertilizer; providing habitat for birds and beneficial insects; and curbing water runoff by improving soil drainage (CalCAN 2019).

Sample Policy

To support rural livelihoods and help transition agriculture toward carbon neutral, and possibly eventually a carbon sink, the US should start paying farmers based on their adoption of specific growing practices that foster soil carbon sequestration. This program should be kept simple, paying farmers based on their adoption of specific growing practices that foster soil carbon sequestration. It could be based on California's Healthy Soils Initiative but scaled to the national level, paying farmers who employ

sustainable soil management practices compensation for the environmental service they provide and subsidizing the transition from industrial farming to more sustainable agricultural practices such as regenerative agriculture. This program could also be broadened to paying rural communities for sustainable forest and land-use management more generally. The program should be fully financed by the federal government.

Of course, this kind of transition to climate sustainability will demand more than a grants program. It will require, for example, vastly restructuring agricultural markets by curbing the market power of agricultural conglomerates, building up processing infrastructure, engaging in outreach and educational programs, and seeding a new generation of farmers. But the importance of this particular program is that it can begin to address the economic needs of struggling farmers in the face of falling commodity prices and the rise of factory farming, while harnessing the vast potential of American farmland to serve as a carbon sink.

Expand Federal Research and Development Spending

Summary

As things stand, the US has the necessary technology to decarbonize the vast bulk of the economy; however, there are some hard-to-abate areas of the economy, such as the industrial sector and heavy-duty transportation. To address these long-term challenges, the US should expand federal spending on research and development. Specifically, the government should immediately increase the funding of the Advanced Research Projects Agency–Energy (ARPA-E) while broadening the scope of ARPA-E to cover other sectors such as industry, agriculture, and heavy transportation.

Background

Cutting emissions by 80-95 percent is technologically feasible at this time, but increased investments in R&D can ensure that energy is affordable, reliable, and safe for people and our collective environment. Government has an indispensable role to play in marshalling in the needed technologies of the future (Mazzucato 2013). That role is not limited to creating the market conditions for private firms to invest in R&D, but it also includes intentionally steering the direction of technological change through direct public investment in R&D. The US has continuously funded and directed technological development through programs and agencies, such as the National Institute of Health (NIH), the National Science Foundation (NSF), the Small Business Innovation Research (SBIR) program, the Defense Advanced Research Projects (DARPA), and ARPA-E.

DARPA, a government-funded program established by the Department of Defense in 1958 to advance military technologies, has led to huge technological breakthroughs that impact every aspect of our daily lives, including the internet, GPS, cloud computing, and artificial intelligence. Following this success, the government created ARPA-E in 2006 through the DOE to focus on advancing technologies in the energy sector based on supporting high-risk, high-reward research (Azoulay 2018). ARPA-E has had great success in energy-related initiatives, including energy efficiency, energy storage, and transportation.

Just as advancements in technologies such as fracking led to the explosion of environmentally destructive fossil fuels, we can envision how large-scale investments in R&D for renewable energy and other areas aimed at decarbonizing the economy could have wide-ranging effects. Since it was funded in 2009, ARPA-E has provided $1.8 billion in R&D funding to over 660 projects. ARPA-E has resulted in 240 new patents, 71 new companies, and billions of dollars in private investment (ARPA-E 2017).

As an example of how public R&D can transform an entire industry, consider the case of solar panels. Solar Photovoltaic (PV) panels have declined in price by about 99 percent over the past four decades (Kavlak et al. 2018). This occurred due to well-crafted public policy that paved the way for PVs. Though there is a well-known result, which demonstrates that prices drop about 20 percent for every doubling of cumulative capacity (McDonald and Schrattenholzer 2001), the story is a bit more complicated.[29] While economies of scale played an important role, especially in more recent years, recent work clearly demonstrates that R&D played a critical role in driving down costs, allowing for the scaling up of PVs to take place (Kavlak et al. 2018). From 1980-2012, R&D was responsible for about 60 percent of the cost decline for PVs; while economies of scale were only responsible for a bit more than 20 percent, efficiency gains enabled by the R&D in the first place (ibid.).

If the government were to significantly expand investments in R&D to decarbonize the economy, the government would be helping to ensure that the transition occurs as rapidly as possible while helping to drive down costs for many new and yet-to-be developed technologies. Such an increase in funding is sorely needed due to the fact that despite programs like ARPA-E, the US woefully lags behind many other countries in R&D investments (World Bank 2019; Harvey et al. 2018). Additionally, the R&D should be targeted toward hard-to-abate sectors, such as heavy industry and other sectors of the economy that do not have clear pathways to full decarbonization.

Government has an indispensable role to play in marshalling in the needed technologies of the future.

Industry, for example, accounts for 22 percent of US GHG emissions (EPA 2016). These emissions can be broken down into two categories: emissions attributable to the combustion of fossil fuels for energy use and emissions attributable to the industrial process itself. For instance, products such as cement and steel, used widely in the global economy, are extremely carbon intensive to produce. While some alternatives to these materials are increasingly being deployed, such as wooden high-rises, decarbonizing the production process of heavy industry is paramount to meeting emissions targets. By no means should this be viewed as a reason to slow progress on decarbonizing the economy. Investments in R&D, along with learning by doing as the economy rapidly decarbonizes, will help address the areas where technological development can have the largest impact, resulting in new production processes and materials to fully decarbonize.

Public R&D must play an important role to decarbonize not only the US economy but to expand financially feasible technologies that can be deployed across the globe. However, it is important to recognize that technology is not a silver bullet and that the need for more R&D is no reason to delay immediate action to curtail emissions. The vast majority of the technology needed for a transition is already in place. Public R&D today will make it possible and affordable to achieve the final 5-20 percent of decarbonization in the near future.

29 This 20 percent rule is currently holding true for batteries as well.

Sample Policy

To address the R&D needs of both the US and the global community, the US should significantly expand federal spending on R&D related to decarbonizing the economy. The government should rapidly increase spending on ARPA-E, which focuses on energy, while also expanding the existing program to focus on other hard-to-abate sectors, such as industry, agriculture, and large and heavy transportation. Currently the ARPA-E budget is about $300 million per year (ARPA-E 2016); we recommend that program funding be increased to tens of billions of dollars per year, with some suggesting an annual budget of $30 billion (Smith 2019). The federal government should fully fund this program to ensure that reasonable R&D projects have sufficient funding.

Direct Credit to Green Businesses

Summary

For a variety of reasons, many of the private-sector entities engaging in green investment will face financing constraints. Given the inability or unwillingness of private financial markets to adequately finance green investment, the federal government should take steps to affirmatively direct credit to private investment in decarbonization, including clean energy production, manufacturing, agriculture, and building retrofits. Such "credit policy" builds on a long history of directing credit to socially valuable activities that face credit constraints, including owner-occupied housing, foreign trade, higher education, and small businesses. It will involve a mix of expanded loan guarantees, a new public bank, and direct support from the Fed.

Background

While the Green New Deal will involve a major expansion of the public sector, the majority of new spending on decarbonization will come from the private sector. When such investments are carried out by large, established corporations, specific financing problems do not arise. But much of the private investment will come from smaller businesses, startups, farms, small property owners, and households—all of which may face significant limits in their access to finance. In these cases, even investment with favorable expected returns is often limited by a lack of liquid assets or limited ability to borrow. Decarbonization investment in these sectors will require new policies to ensure that credit is widely available. Policies to direct credit to specific sectors or activities is called "credit policy," in contrast to conventional monetary policy, which merely seeks to influence the overall level of credit or liquidity in the economy as a whole.

It is clear that even in an environment of abundant liquidity, there is no guarantee that decarbonization investment will be adequately financed. Many small- and medium-sized enterprises may have promising projects but are unable to obtain financing because of information asymmetries or other market failures. This is especially likely with startups focused on new products and/or processes—exactly the sort of innovation that decarbonization in manufacturing in particular is likely to require. There is a reason why Silicon Valley startups rely on a specialized venture capital sector rather than conventional bank finance; but no similar specialized funders exist for investments in decarbonization. Empirical research shows that while large corporations are relatively impervious to shifts in financial conditions, access to bank credit can be a major factor in investment by smaller and newer businesses (Chodorow-Reich 2014). Similarly, many households may be excluded from credit markets because of reasons like low current income, precluding even investment in home energy-efficiency that could quickly pay for themselves.

As Nobel laureate Joseph E. Stiglitz (2013) puts it, "Governments and central banks need to have explicit programs to encourage lending to certain groups/sectors that are underserved." In general, it is clear—and has become increasingly evident since the housing bubble and financial crisis of the 2000s—that private financial markets cannot be relied on to direct credit to the most valuable uses. Government must play a positive role in allocating credit (D'Arista and Boyce 2002). Ensuring that credit flows to renewable energy and other green investments is a critical part of a comprehensive decarbonization program.

Credit policy has long been used in the US and other rich countries to direct bank lending and other forms of finance to areas deemed national priorities. In order to ensure that specific classes of borrowers had access to credit on acceptable terms, the Fed targeted a number of different interest rates and purchased bankers' acceptances as well as federal debt in the 1920s (Carlson and Duygan-Bump 2016). During World War II, the federal government financed the great majority of new industrial capacity, even when the factories themselves were privately owned (Mason 2017a). During the financial crisis, the Fed took further steps to support credit for specific institutions and sectors. During 2007 and 2008, it was the decisions of the Fed that determined which troubled financial institutions would survive, which would be absorbed by other institutions, and which, like Lehman Brothers, would be allowed to fail. During the summer of 2008, when the commercial paper market that provides short-term financing to the nation's largest corporations had essentially ceased to function, the Fed stepped in to replace private lenders. By making loans directly to nonfinancial, as well as financial, businesses that had previously borrowed in the commercial paper market, the Fed effectively replaced private banks as the source of short-term loans for corporate America. During the slow recovery that followed, the Fed continued purchasing large volumes of mortgage-backed securities, effectively serving as the ultimate lender for a large fraction of new mortgages issued in the years after 2010.

Building retrofits are a particularly promising target for credit policy. Because these retrofit projects combine upfront costs with savings over a long future period, they are natural candidates for debt financing. But the dispersed building owners, the information problems, and, in the case of commercial structures, the transaction costs often created by the separation of ownership from liability for utility bills mean that there is a natural role for a public agency to facilitate lending.

Concretely, a decarbonization credit policy would include three components. First, a new and/or existing federal agency should offer loan guarantees for green investments by small businesses, farmers, and homeowners. These are a commitment by a government agency to absorb some fraction of the losses from defaulted loans to designated borrowers. Loan guarantees are a natural way to allow the federal government to use its status as a privileged borrower to support credit flows to private businesses, and they are one important tool to direct credit to socially useful private projects. The value of loan guarantees comes from the existence of pervasive information problems in private credit markets. In a world of perfect information, a loan guarantee would simply be a subsidy. But because of information problems in credit markets, there are a number of loans that are not made even though they would offer positive private returns. By offsetting the risks created by information asymmetries, a loan guarantee program can support increased lending with private and social returns much greater than the required outlay of public funds. A renewable-energy loan guarantee program was included in the 2009 American Recovery and Reinvestment Act (ARRA) stimulus bill, and the high-profile failure of one recipient (Solyndra) attracted a great deal of public attention and criticism. But Solyndra was one of only two of the 24 companies that received loans under the program that defaulted; the ratio of public money actually spent to new lending generated was very favorable and the program ended up being profitable (Pollin 2014).

Second, a public investment bank should be established to lend directly to startups and other small businesses for decarbonization investment. This will be particularly important for carbon-neutral manufacturing, as well as for renewable energy producers.

Third, the Fed should incorporate a decarbonization mandate into monetary policy. This involves maintaining low interest rates—as discussed in the macroeconomics section below. Permanently low interest rates make it easier to finance the expanded public and private spending that decarbonization will require. In addition, the Fed should purchase debt issued to finance green investment, either directly or via the public investment bank.

Ensuring that credit flows to renewable energy and other green investments is a critical part of a comprehensive decarbonization program.

Sample Policy

The federal government should take a three-pronged approach to ensure that investment in decarbonization by private businesses and households is not limited by lack of access to credit. First, it should greatly expand loan guarantee programs for green investment. Second, it should establish a new public investment bank to lend directly to small businesses. Third, the Fed should support decarbonization both by committing to keep interest rates low and by buying debt issued to finance decarbonization, either directly or from the public investment bank.

A loan guarantee program could be similar to the Department of Energy Loan Guarantee Program included in the ARRA stimulus bill but on a much larger scale. While the ARRA program guaranteed $14 billion in loans over five years, the goal for a new program should be to guarantee at least $25 billion in eligible loans per year. One recent study of loan guarantee programs suggests that it is reasonable to expect an annual default rate of 10 percent and a recovery rate of 50 percent (Pollin 2014). Given these assumptions, a program covering 80 percent of default losses could support $20 billion in increased loans with an outlay of less than $750 million per year.

The second prong of decarbonization credit policy is one or more specialized public banks. Infrastructure banks have been proposed in the past; in the decarbonization context this would be a bank with a specific focus on investment in carbon-neutral manufacturing and renewable energy. Such a bank could also make long-term loans to state and local governments, public-private partnerships, and private businesses to finance decarbonization investment. The federal government would provide the initial capital, and the bank would be publicly owned. Going forward, it could finance itself by issuing its own bonds, which could then be bought by the Fed. The advantage of such a structure is that it frees the Fed of needing itself to develop the capacity to assess and evaluate green investment projects. Insofar as the green infrastructure bank's bonds were marketed to the private sector, they would also help satisfy the world's demand for safe, liquid-dollar assets. In Europe, a similar approach has been suggested via the existing European Investment Bank (De Grauwe and Ji 2019).

Two important areas for credit policy that may require more specialized public institutions are financing for building retrofits by homeowners and other small property owners as well as green investment by farmers. These borrowers are particularly likely to face credit constraints and are also most likely to face information problems—both on the side of lenders assessing their projects and on the side of borrowers taking advantage of available financing opportunities. For these reasons, it will be desirable to have specialized public bodies to support lending in these areas. These could be public entities that lend directly to homeowners and farmers, along the lines of the US Department of Agriculture's (USDA) existing Farm Loans Program. Alternatively, it may be preferable to take advantage of the specialized knowledge and relationships of existing private lenders and channel credit to these sectors through secondary purchases and/or guarantees of their debt, as with Fannie Mae and similar programs to support home mortgage lending.

Finally, the Fed should play an active role in supporting decarbonization. Most straightforwardly, this implies leaving interest rates lower than it might otherwise choose to, since low interest rates will facilitate both expanded public borrowing and private investment. In addition, the Fed should directly act to channel credit to decarbonization, by buying debt issued to finance it. Just as the Fed today buys securitized mortgages to support the home mortgage market, and during the crisis bought a wide range of private debt to support lending in general, the Fed should purchase both public and private debt issued to finance investment in decarbonization on an ongoing basis. In particular, once a public investment bank is established, the Fed should buy its bonds, ensuring that it can finance large-scale lending. To the extent that this requires a change in the Fed's legal authority, this should be provided by legislation. But the experience of the 2008-2009 crisis suggests that the central bank can already take expansive action in support of specific financial markets when it believes that it is urgent to do so.

Helping Vulnerable Communities Adapt to Climate Change

Summary

Though adaptation policies are crucial for helping the US prepare for and combat the climate crisis, we must be careful that these strategies do not exacerbate existing economic and social disparities. Instead, policymakers must target policies in ways that protect vulnerable groups from the disproportionate effects they currently experience and will experience from climate change. Federal funding can provide support for frontline and economically vulnerable communities to build resilient adaptation systems, which can also foster climate mitigation.

Background

As climate disasters—droughts, flooding, hurricanes, etc.—increase and intensify, some state and local governments are beginning to plan and prepare for the challenges associated with a warming planet. Examples include: building and repairing structural seawalls that protect from sea-level encroachment, weatherproofing homes and businesses, reestablishing wetlands, and even relocating entire communities. According to Susanne Moser, the leading US expert on climate adaptation, the first climate adaptation policies date back to the 1980s with "'Maine's Sand Dune Rules,' the California Coastal Commission's and San Francisco Bay Conservation and Development Commission's initial sea-level rise policies" (2014). Georgetown Climate Center now reports that approximately 16 US states have completed an adaptation plan, with a handful of others in the works.

State and local adaptation planning fall into two categories: stand-alone plans and integrated policy plans that bake climate adaptation considerations into existing governance structures. In terms of mainstreaming adaptation policies into existing governance structures, the following are a few examples.

> Common arenas targeted for mainstreaming include shoreline/coastal management (e.g., Louisiana; Maui Co., HI; Buzzards Bay, MA; City of Ft. Lauderdale, FL); disaster preparedness and hazard mitigation (e.g., Connecticut; City of Lewes, DE; Dane County, WI); general planning (e.g., Marin County, CA; City of Virginia Beach, VA); smart growth and urban redevelopment (e.g., Florida; New York City); conservation or wildlife management (e.g., Alaska; Iowa; Kentucky; Oregon); public health (e.g., Michigan); transportation (e.g., Maine; New York); water resources planning (e.g., Arizona; City of Phoenix, AZ); Santa Clara Valley Water District, CA); utility planning (New York City); economic development (Homer, AK); and so on (Moser 2014)

As more state and local governments develop adaptation plans for their communities, it is crucial that they recognize existing income and social disparities and think through the ways in which these policies could exacerbate or mitigate them. As New America fellow Virginia Eubanks describes, Troy, New York, passed a $2.25 million bond measure to use with almost $7 million from Federal Emergency Management Agency (FEMA) to repair the city's seawall. Yet as Eubanks states, "the seawall only protects the city center, home to the gentrifying downtown arts district and waterfront redevelopment." This leaves many poor and working-class families without protection from future floods (Eubanks 2016).

Grabar (2016) describes bias in the Army Corps of Engineers' methods for deciding which towns and cities will receive flood defenses like walls, levees, and dunes. Their cost-benefit analyses categorize many communities as ineligible for these projects because they are based on a lower market value of existing structures, but this is partially an artifact of our racialized housing policies, which have long held down the market value of certain communities. Ultimately, a safe environment is a fundamental human right, not something that should be determined by a market efficiency criterion.

Sample Policy

Adaptation planning and implementation have thus far been a mixture of efforts at the state and local levels rather than the national level, but the federal government must play the primary role in funding adaptation innovation at the local and state levels. Financing and funding are huge constraints for local governments implementing adaptation plans. Furthermore, federal funding can help target some subset of adaptation funding directly to climate vulnerable communities.

A federal grants program that would provide financing for vulnerable communities to implement adaptation methods that suit their specific needs and environment should be established. This program would work with communities to not only help them determine their adaptation plans but also to find ways to tailor, when possible, adaptation methods to also mitigate climate emissions. For example, this funding could support low-income communities that need to retrofit housing with green roofs to help cool them more efficiently and cheaply, alleviate urban heat island effects, absorb dust and pollutants, and control storm water drain-off (Li and Babcock 2014). This funding could also be used to help farming communities build soil health, which sequesters carbon and build resiliency against pests and drought, not to mention enhances agricultural productivity. Ultimately, this funding program can highlight the ways that adaptation policies can be designed to be both inclusive and help us fight climate change.

SECTION 2

The Macroeconomic Case for a Green New Deal

While the Green New Deal is most obviously motivated by the urgency of the problem of climate change and decarbonization, it is also a response to current macroeconomic conditions. In an economy that suffers from chronic demand shortfalls, and in which labor's share of income is steadily falling, there is a strong case for any program that involves increased public spending or that encourages private investment. In this case, the real resources required by the Green New Deal should be seen not as a cost but as a benefit.

In Section 2.1, we discuss the chronic shortfall of aggregate demand facing the US as the essential macroeconomic context for a program of crash decarbonization. In Section 2.2, we discuss how the program will be financed—what mix of new debt and taxation might plausibly offset the increased public spending involved.

Overview

While it is too early to put a definite number on the cost of the Green New Deal, we may be looking at additional spending (public and private) in excess of 5 percent of GDP, sustained over many years. Regulations, credit policy, and carbon pricing will substantially alter the composition of private spending, across activities, industries, and labor markets. One way or another, raising and redirecting spending on this scale will have major effects on labor markets and income distribution. The question is only whether these impacts come haphazardly or openly and deliberately. The economic impacts of a public spending program are often discussed in terms of "costs." But, we argue, in an economy with substantial excess capacity, claims on real resources by the public sector should be seen not as costs but as benefits.

The link between public spending, aggregate demand, labor market conditions, and wage growth is important to unpack. Aggregate spending (or demand) determines the level of economic activity in the short term. In the absence of hard supply constraints, it may have a decisive impact in the medium to longer term as well; arguably, this is the case for the US economy today. The level of activity in turn determines the level of employment and labor market tightness, which plays a central role in the level and distribution of wage growth.

Textbook macroeconomic theory says that the wage share of national income is determined on the supply side—by the marginal product of labor as determined by human capital and production technology. But economists are increasingly recognizing that this textbook story misses the essential role played by both labor-market institutions, such as unions and regulations, and by labor market conditions as determined by aggregate demand. When tight labor markets lead to faster wage growth, this does not merely result in higher inflation but leads to a higher wage share in national income and, often, to faster productivity growth—both of which imply an increase in real and not just nominal wages. In this view, the stagnant wages for the majority of Americans and the secular fall in the wage share over recent decades are not the inevitable result of automation or competition with low-wage countries abroad; they are a reflection of the weak bargaining position of American workers—weakness due in large part to chronic shortfalls in aggregate demand.

Prior to the recession of 2008-2009, it was widely believed that central banks could and should take sole responsibility for closing gaps between demand and potential output. Conventional monetary policy, using a single interest rate as its instrument, was supposed to be able to rapidly and reliably close any output gap. This view is much less widely accepted by economists today. Many would say that the experience of the Great Recession, in which unemployment remained above the Fed's target for seven full years despite the Fed's interest rate being at zero, has decisively refuted this view. And there is no reason to think that this recession was unique. In the economy we live in, aggregate demand seems to secularly fall short of the economy's potential output; monetary policy (quantitative easing as well as conventional policy) seems to have limited ability to close the gap; and to the extent that it is able to do so, it is at the cost of regular asset bubbles, which impose their own steep costs.

This situation is sometimes described as one of "secular stagnation" (Summers 2014). In an environment of secular stagnation, there is no reason to expect the level of demand to keep up with the economy's potential; productivity growth will fall short of what is technologically feasible; and with chronically weak labor markets, wages will fall short of even the depressed rate of productivity growth, leading to a declining share for labor out of national income. The only solution is systematic government action to raise the level of both private and public spending. An increasing recognition of this fact is leading even

mainstream policy economists, like former Council of Economic Advisors (CEA) chair Jason Furman, to suggest that more expansionary fiscal policy should be adopted on an ongoing basis and not just in response to temporary downturns (Furman 2016). More broadly, it means that the real resources required by a massive economic program like deep decarbonization are not being withdrawn from other uses but rather will call forth production that would otherwise not take place.

More broadly, it means that the real resources required by a massive economic program like deep decarbonization are not being withdrawn from other uses but rather will call forth production that would otherwise not take place.

The case for substantially more expansionary macroeconomic policy is even stronger if we believe in "hysteresis," as an increasing proportion of economists do (Ball 2009). Hysteresis refers to lasting effects of demand conditions—especially weak demand—on potential output. In a world with hysteresis, spending more money today not only boosts output and employment today, it also boosts output and employment in the future, even after the spending has ended. When relatively strong or relatively weak labor markets cause people to move into or out of the labor market, the effects are persistent beyond that period. Business investments in new production technology and worker training—or their absence—are likewise persistent beyond the period in which they take place. In a world with substantial hysteresis, it is entirely plausible that a massive program of decarbonization could—apart from its critical environmental benefits—leave output and consumption in other areas of the economy also substantially higher. The same people who are drawn into the labor force and acquire new skills and work experience through a Green New Deal, will continue to benefit for the remainder of their working lives. Similarly, new equipment and software created, as well as new technologies and production processes developed, for purposes of decarbonization will continue to be available for the benefit of the economy well into the future. This also means that, as economist and former Treasury Secretary Lawrence Summers and others have argued, increased public spending can pay for itself, if it has even a modest effect on long-run growth (Fatás and Summers 2018).

We need to avoid the misleading idea that an economy is equivalent to an individual household or business, where spending in one area must come at the expense of spending somewhere else. In a chronically depressed economy, higher spending in one area can crowd *in*, rather than crowd out, spending in other areas. Just as important, at the macroeconomic level, spending has important distributional consequences. It is impossible to raise wages without a period of strong demand and tight labor markets. This is especially critical for those at the bottom of the income distribution—people who are at the end of the hiring queue because of a lack of education or other credentials, sex, race or ethnicity, geographic location, or other reasons, are precisely the ones whose employment and wages are most dependent on a strong labor market (Bivens and Zipperer 2018). While it is sometimes argued that decarbonization should not be linked to a broader egalitarian economic program, in fact a more egalitarian economy is a natural outcome of a program of rapid decarbonization—as long as it comes through increased public and private investment and not merely through carbon pricing.

Because the official unemployment measure is today below 4 percent—3.6 percent as of April 2019—some might argue that there is no significant slack in the economy. This would mean that labor and other resources required for a Green New Deal would have to be withdrawn from the private sector somehow, whether by higher taxes that discourage private spending, higher prices, or more direct controls. There is good reason to believe, however, that the historically slow growth rates of the past decade or more reflect weak demand. In this case, a program like the Green New Deal should be seen as a way of *raising* incomes and living standards, rather than it being a cost that must be subtracted from them.

There is good reason to believe that the historically slow growth rates of the past decade or more reflect weak demand. In this case, a program like the Green New Deal should be seen as a way of raising incomes and living standards, rather than it being a cost that must be subtracted from them.

In the following subsections, we briefly summarize the evidence that the US economy does indeed face a chronic shortfall of aggregate demand. In summary: GDP remains well below its pre-recession trend. The employment-population ratio has fallen by more than can be plausibly explained by demographics, and wage growth is also slow. Inflation—the textbook signal of an economy approaching supply constraints—remains low. Despite high profits, business investment remains relatively low, while cash holdings and payouts are high, suggesting limited investment opportunities. Finally, it is important to keep in mind that a decarbonization program will extend across many years, a period during which a recession or deeper downturn is likely to occur. Therefore, the macroeconomic context for a program to greatly extend public and private spending should not be imagined solely in context of today's relatively strong economy; rather, it should be considered as a mix of current conditions and conditions of much weaker demand. Embarking on a program of rapid decarbonization today ensures that, unlike in 2009, there will be "shovel-ready" projects in the next cyclical downturn—areas where spending can be ramped up immediately without a long planning process.

Section 2.1 The Case for Unused Capacity

GDP versus Trend

By the official measures of potential output, the US economy is today operating at full capacity, for the first time since 2007. Not much weight can be placed on this, however; the way that estimates of potential are constructed guarantees that output must eventually return to estimated potential. A standard way of correcting potential estimates for the possible impact of demand shocks is to look at estimates of potential that were made before the demand shock. In this case, that means looking at estimates from 2008 and before. When we do this, we see that official forecasters like the Congressional Budget Office (CBO) and Social Security Administration predicted that real GDP per capita would continue rising at close to the 2 percent annual rate that had prevailed historically—rather than the 1.3 percent rate we have

actually experienced. In other words, the closing of the output gap over the past decade has come entirely through the downward revision of estimates of potential output. Relative to forecasts made before the crisis and recession, there has been *no* recovery. GDP remains more than 15 percent below the level forecast in 2008.

This estimate is supported by more sophisticated efforts to assess the impact of the crisis. Recent research suggests that the slow productivity growth of the past decade is in large part the result of weak demand (Anzoategui et al. 2016). For example, one study by economists at the San Francisco Federal Reserve bank observed that "over the past 10 years imply that actual US GDP ... converged on a new potential level ... that was about 12 percentage points below the level implied by its pre-crisis trend" (Barnichon et al. 2018). This gap, they suggested, has little or nothing to do with "structural" factors like demographics or technological exhaustion; rather, it represents the ongoing effects of the financial crisis and deep recession of 2008-2009. "Without the large adverse financial shocks experienced in 2007 and 2008," they argue, "the behavior of GDP would ... most likely resemble the less severe 1991 recession, with GDP declining by only 1.5 percent and reverting to close to its pre-crisis trend level in a few years." Thus, the Green New Deal should be seen as a program to address the climate crisis and the substantial macroeconomic crisis *simultaneously*.

If one takes estimates like these seriously, there is on the order of a 10 percent gap between the economy's productive potential as of a decade ago and the level of output we are currently producing. This does not, of course, mean that federal spending could be increased by 10 percent overnight without generating any price increases or bottlenecks. The more rapidly spending is increased, the more affirmative non-market measures will be needed to redirect resources. However, this does suggest that if spending were ramped up over a number of years, it's possible that aggregate spending on decarbonization could be raised by as much as $2 trillion per year without any reduction in current public and private spending.

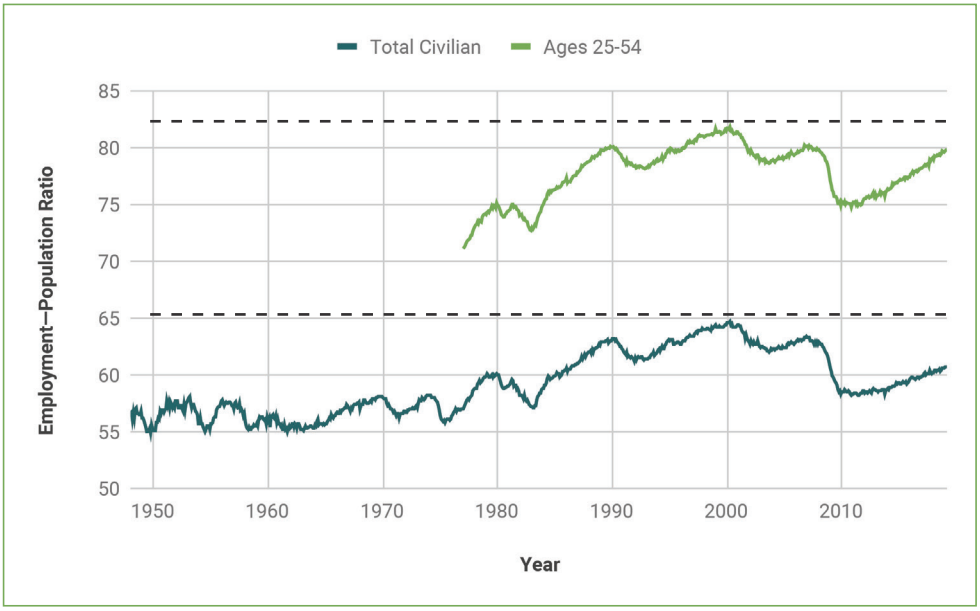
Labor Markets

As with the output gap, there are good reasons to think that the official unemployment rate substantially understates the real slack facing the economy. Though headline unemployment is low by recent standards (though still well above the 1.7 percent of 1943-45), the labor force participation rate remains low at just 63 percent, well below historical levels such as 67 percent in the late 1990s (BLS 2019a). This means that the employment-population ratio (the fraction of the adult population with jobs) is just 61 percent, compared with 66 percent in 2007 and as high as 67.3 percent in 2000 (BLS 2019b). That represents approximately 15 million adults neither working nor seeking work. These kinds of considerations have led prominent economists like former International Monetary Fund (IMF) Chief Economist Olivier Blanchard (2018) to suggest that "there is a strong case ... to allow US output to exceed potential for some time, so as to reintegrate some of the workers who left the labor force during the last 10 years."

FIGURE 5:

Employment-Population Ratio, 1948-2019

The fraction of the population employed, for all civilians 16 years or older (lower line) and for those aged 25-54 (upper line). The horizontal lines show the historical peak values.



Source: BLS.

While some of this decline reflects the aging of the population, this is not the whole story. Even among "prime-age" (24- to 54-year-old) adults, the fraction in the labor force is 2 full points below its pre-recession level (BLS 2019c). Among young people (20 to 24), participation is down a full 6 points. There is strong evidence that much, if not all, of this decline represents the ongoing effects of the exceptionally weak labor market of the recession and jobless recovery. A recent Roosevelt Institute study suggested that at most half of the decline in labor force participation can be explained by demographic factors—a similar finding to those of studies by the CEA and the Levy Institute (Mason 2017b; Dantas and Wray 2017). It is notable in this context that the relatively strong labor market of the past couple of years has seen a slow but steady rise in labor force participation, suggesting that people who dropped out in previous years are slowly returning to the labor market. This implies that the increase in employment associated with the Green New Deal could mobilize currently underutilized labor rather than bidding workers away from existing private employers.

Another important sign that there is still substantial slack in the labor market is the weak wage growth in the current expansion. Labor's share of income remains well below that of a decade ago and even further below the share in the year 2000 (University of Groningen and University of California, Davis 2016). Nominal wages for nonsupervisory workers are up less than 3 percent per year over the past three years, significantly less than during the already weak 2000s expansion and much less than in the expansion of the 1990s (University of Groningen and University of California, Davis 2016). For anyone concerned with income distribution, this is a strong argument for policies to boost demand. The only way for labor's share to return to its levels of the 1990s is for the US to experience a sustained period of "overfull" employment, with wage gains regularly outpacing productivity. We are still far from that today (Bivens 2019).

FIGURE 6:

Labor Share, Non-Financial Corporations, 1960-2018

Total labor compensation (wages plus benefits) as a share of value added in the nonfinancial corporate sector.

Source: BEA Integrated Macroeconomic Accounts.

There is strong statistical evidence that weak demand, and in particular weak wage growth, also has a depressing effect on productivity (Girardi et al. 2018). When workers are plentiful and customers are scarce, there is little reason for businesses to invest in labor-saving (i.e., productivity boosting) technology, and there are few opportunities for new, more efficient businesses to get underway. Conversely, when labor is scarce but markets are growing rapidly, businesses have a strong incentive to improve their production techniques as much as they can. Economic historian Gavin Wright (2006) argues that this is the true story of the productivity "miracle" of the 1990s. Many of the basic information-technology innovations (e.g., bar codes or electronic stock-tracking) that raised productivity in this period had been available for many years, but businesses only adopted them widely when wage growth made it cost-effective to do so. The converse story is visible in the decade since 2008, with low productivity growth the natural result of abundant labor and stagnant demand. If productivity depends on demand in this way, that suggests the existence of an intensive as well as extensive margin of unused capacity, which rapid decarbonization could unlock.

Inflation

The most obvious sign that the economy is not yet facing supply constraints is the fact that inflation remains subdued. In an economy operating close to potential, we would see prices rising as more and more sectors found themselves unable to increase production in line with desired purchases. Until and unless prices begin to rise, it is hard to argue that the economy lacks the real resources to support additional public spending.

Even if inflation does rise, this need not lead to an out-of-control spiral into hyperinflation—which means the costs of higher inflation need to be weighed against the benefits of running the economy hot.

Until and unless prices begin to rise, it is hard to argue that the economy lacks the real resources to support additional public spending.

The first point to take from this is that there is space in the economy for a substantial expansion of spending without offsetting taxes, without the risk of inflation. That is very important. But even more important is the second point—that an economy operating below potential creates massive costs in lost output, in productivity, technological progress, wage growth, unemployment, social stability, and well-being. These costs are systematically undervalued by orthodox policymaking. As Roosevelt Fellow Mike Konczal (2018) puts it, "when economists try to pick a 'natural rate,' they err in the same direction every time—the direction that hurts workers." The goal of the Green New Deal is not simply to redirect resources on the assumption that aggregate output is given—the framework of far too much economic analysis of climate change. Rather, it is premised on the idea that one of our most urgent macroeconomic problems is a chronic shortfall of aggregate demand. In a world suffering from secular stagnation, aggregate output is not limited by real resources but by spending. In this setting, increased spending leaves us collectively richer—both financially and socially.

Investment and Corporate Cash Holdings

There are signals indicating that large amounts of unused capacity on the business side exist as well. The Bureau of Economic Analysis' (BEA) standard measure of capacity utilization shows lower values than in the previous two expansions (Board of Governors of the Federal Reserve System 2019). Business investment, while not weak in absolute terms, is still not as high as in previous booms, especially given today's exceptionally high level of corporate profits. During the late 1990s and early 2000s, nonfinancial corporations invested as much as 75 percent of their gross operating surplus.[30] Today, that figure is less than 60 percent. This is an important benchmark since it gives us a sense both of the financial capacity of corporations to sustain a higher level of capital outlays and of the level of investment we might expect in a situation where major new technologies were being introduced and a fundamental reorientation of production was taking place (BEA IMA Table S.5.a.).

At the same time, corporate cash holdings and payouts to shareholders are both at record levels. Nonfinancial businesses today hold cash and equivalents equal to 15 percent of total value added, compared with a long-run average of under 10 percent. And shareholder payouts (dividends plus share buybacks) have averaged over 7 percent of value added in recent years, compared with a long-run average of under 3 percent (BEA IMA Table S.5.a.). Both of these developments suggest that corporate investment is fundamentally constrained by a lack of demand, rather than a lack of profits or financing.

Business investment responds not only to demand but to fundamental shifts in economic activity. Historical investment booms, for example, are invariably associated with the spread of new technologies that led to

30 Gross operating surplus is equal to operating profits plus depreciation; it is the appropriate measure to compare with gross investment.

large-scale reorganization of production, from electricity in the 1920s, to the shift from rail to highways in the 1960s, to information technology in the 1990s. These shifts make large swathes of old capital obsolete and call forth massive new investment to replace it. Decarbonization promises to unleash a similar wave of creative destruction. By requiring or encouraging businesses to reorganize production and distribution to be carbon neutral, it will call forth a great deal of new private as well as public investment and activate the currently underused capacity—real and financial—for capital formation of corporate America.

The Business Cycle

It is not enough to "allow" output to exceed potential. Affirmative measures must be taken to keep demand strong, especially when—as is certain to happen in the next few years—private investment begins to falter. The Green New Deal can play a critical role here.

Each of the past three recessions has been followed by long "jobless recoveries" in which unemployment remained well above the Fed's target for four, five, or in the most recent cycle seven years after the end of the formal recession. Taking the official statistics at face value, since 1980, there have been 192 months when the unemployment rate was more than one point above the non-accelerating inflation rate of unemployment (NAIRU), and only 18 months when it was more than one point below. Given that record, we shouldn't evaluate the desired level of public spending on the assumption that the risks of overshooting and undershooting potential are about equal. Since 1980, policymakers have struggled much more often to stimulate the economy than to restrain it.

The asymmetric macroeconomic risks facing us are well-illustrated by the experience of the past 10 years. Conventional monetary policy was unable to offset the effects of the crisis, at least in part because the short-term interest rate was stuck at zero—the familiar problem of the zero lower bound. The result of this was trillions of dollars of lost output and millions of people suffering years of unemployment and poverty. It's worth recalling that the stimulus bill of 2009 was hampered by a lack of "shovel-ready" public projects—areas where spending could be ramped up immediately, without a long planning process. There is a strong argument for laying out an expansive public spending program now—before it becomes macroeconomically urgent in the next recession.

There is a strong argument for laying out an expansive public spending program now–before it becomes macroeconomically urgent in the next recession.

Section 2.2 Financing Decarbonization

The Green New Deal will involve substantial outlays of both public and private money. While it is impossible to cost out these proposals in a rigorous way until they are embodied in legislation, it is still possible to discuss the options for financing it. The United States today has substantial capacity to increase both public debt and taxation; it should be possible to finance a decarbonization program of at least 5 percent of GDP a year, sustained over a decade or more, without significant economic dislocation.

All public expenditures must be financed—that is, for each dollar of spending, there needs to be a corresponding source of funds. This constraint, that total uses of funds must equal total sources of funds, applies equally to the public sector and to the private sector.

The financing question is important and should not be avoided. At the end of the day, however, the real constraint on the scale of decarbonization is not generating the appropriate money flows but the labor and other real resources available in the economy. The question of "Can we afford it?" is not a serious question if it means whether the government can generate the necessary sources of funds; it can. It is a serious question if it concerns the real resources available to the economy; here, again, we believe the answer is positive.

It is useful to subdivide the financing side into several parts.

On the public side, increased public spending on decarbonization will be matched by some mix of new borrowing, higher tax revenue, and reduced spending in other areas.[31] On the private side, a range of financing approaches will be involved. To some extent, regulation will simply lead to the redirection of existing private investment flows. Some private spending will be financed by public subsidies, financed in turn by the same mix of sources as other public spending. An important part of the financing puzzle for the private sector, which does not apply to public spending, is credit constraints; programs to redirect credit to green activity will be necessary, as discussed in Section 1 above.

We will discuss these issues in turn.

On the public debt side, perhaps the most important thing to understand is that today's low interest rates make increased public borrowing much easier to sustain. When interest rates are higher than GDP growth rates, as in the 1980s and 1990s, maintaining a stable debt ratio requires "paying for" all public spending, in the sense that higher deficits in one year must be compensated for by higher surpluses in a later year to keep the debt ratio on track. When interest rates are lower than growth rates, as is true today, borrowing does not need to be paid for in this sense; after a period of high deficits, the debt ratio will stabilize on its own without any need for offsetting surpluses. If increased public spending boosts economic growth, that will further moderate any rise in the debt ratio. And there are good reasons to believe that for the US, a higher public debt-GDP ratio would not impose major economic costs and would have significant benefits.

At the same time, it may well be desirable to finance some part of increased public spending through tax increases (or spending reductions in other areas). "Pigouvian" taxes—taxes on social harms—could raise significant revenues. Since these taxes—such as carbon taxes, taxes on very high incomes and wealth, and

31 Financing options for an expanded public sector are discussed at greater length in the Roosevelt Institute issue brief, "Fiscal Rules for the 21st Century" (Mason 2019).

financial transaction taxes—are desirable for their own sake, imposing them should not be regarded as a cost. Finally, to the extent that broad-based taxes are necessary or desirable, it is important to note that the US is currently a low-tax country compared with the rest of the rich world.

Both the public and private financing questions need to take into account the international role of the dollar. While issues of international trade and finance are typically treated as entirely distinct from those involved in a domestic initiative like a Green New Deal, in fact they are tightly linked. The demand for safe assets by central banks and private institutions in the rest of the world can be channeled into both public and—with appropriate guarantees and regulation—private liabilities financing decarbonization.

Public Debt

As discussed in this report, the Green New Deal is a broad mix of initiatives whose relative impact will be hard to assess except through trial and error. It is a direction of travel, not a single specific policy proposal. So it is not possible to make more than a broad guess about the level of additional public spending involved. As a rough guideline, Robert Pollin suggests a figure of 1.5 percent of world GDP for a global Green New Deal involving broadly similar elements to those involved here (Pollin 2015). This number is probably too low for a Green New Deal in the US. This is partly because the US—as the largest rich country and the largest historical contributor to GHG emissions—should be expected to do more than its proportional share. (The US is also less constrained financially than most other countries, as discussed below.) This number is also likely low because the proposals under discussion today are even broader than those considered by Pollin. Though we do not believe it is possible to precisely cost out our proposals at this stage, we might use as a benchmark new public spending on the order of 3 to 5 percent of GDP—$600 billion to a $1 trillion—sustained over a decade or more.[32] How much of this could reasonably be financed through additional borrowing?

A common definition of debt sustainability is that the fiscal position be such that the debt ratio will stabilize at some finite value (i.e., that it will not rise without limit). In this sense, with interest rates less than growth rates ($r < g$), any primary deficit is sustainable. A permanent increase in public borrowing, no matter how large, will always still result in the debt ratio converging to some finite value. And a temporary increase in borrowing, no matter how large, will always result in the debt ratio returning to its old value once the period of temporarily higher borrowing is over.

The idea that there is a tipping point, where deficits can lead to debt spiraling out of control, made a certain amount of sense in the 1980s and 1990s, when interest rates on public debt were indeed greater than GDP growth rates. But for the past 15 years, the average interest rate on government debt has been consistently below the growth rate of GDP, and there are good reasons to believe that this situation will continue indefinitely. A number of prominent macroeconomists have pointed out how this fundamentally changes the calculations around debt sustainability. This was the central point of Blanchard's keynote talk at the American Economic Association's annual meeting in January 2019: In a world of low interest rates, the costs of high government debt are much lower than many economists had previously believed. "Put bluntly," he says, "public borrowing may have no fiscal cost" (Blanchard n.d.). Lawrence Summers and Jason Furman recently made a similar argument in an article in *Foreign Affairs* subtitled, "Why Washington Should End Its Debt Obsession" (Furman and Summers 2019). Even Kenneth Rogoff, best known for a paper arguing that high government debt could have serious negative effects on the economy, recently repudiated its conclusions in a column titled, "Never Mind the Debt" (Rogoff 2019).

32 This is intended to cover the kinds of decarbonization initiatives discussed in this report, which are focused on the climate aspects of a Green New Deal. It is not intended to cover universal healthcare, a job guarantee, or similar broader economic justice proposals, outlined in the Green New Deal resolution. Those will require their own additional financing.

These conclusions are based on today's low interest and growth rates. If a program of debt-financed public spending could significantly boost growth, the effect of higher public spending on debt would be even less. First, most directly, higher GDP would raise the denominator of the debt-GDP ratio, leaving the ratio smaller. Second, faster growth leads to higher tax revenue, independent of any decision to change tax rates. Together, these two effects mean that if higher public spending has a sustained effect on GDP—even a small one—it is quite possible for it to substantially pay for itself, in the sense that even without any new tax increases the debt ratio will rise by considerably less than the accumulated deficits.

So the question of how much borrowing is reasonable to finance a Green New Deal, depends on our assumptions about interest rates and growth rates, and about the persistence of demand effects, as well as about what level of debt-GDP ratio is desirable.

This is clearer if we provide some numbers.

As of March 2019, the five-year, 10-year, and 30-year Treasury bonds are trading at 2.3 percent, 2.7 percent, and 3.0 percent, respectively. The average maturity of federal debt is just under six years, so the average interest rate on borrowings at today's interest rates is around 2.5 percent.[33] Nominal GDP growth rates have been around 5 percent since the end of the recession; this also is low by historical standards. Based on the evidence of the past decade, we can expect growth rates (g) to be 2 to 3 points above interest rates (r).

The CBO is currently projecting primary deficits of 2.7 percent of GDP over the next five years. At current interest and growth rates, that implies a gradual rise in the debt ratio; from its current 75 percent, it will reach only 83 percent a decade from now. The CBO's official projections call for a much larger rise in the debt ratio, to 93 percent by 2029. That is because they assume that over the next few years there will be a significant increase in the interest rate on government debt. It is important to recognize that this projected rise in interest rates, and not the primary deficit, is the most important driver of the CBO's forecast of a near 20-point rise in the debt ratio over the coming decade. At current interest and growth rates, the fiscal position, even after President Donald Trump's tax cuts, is close to balanced.

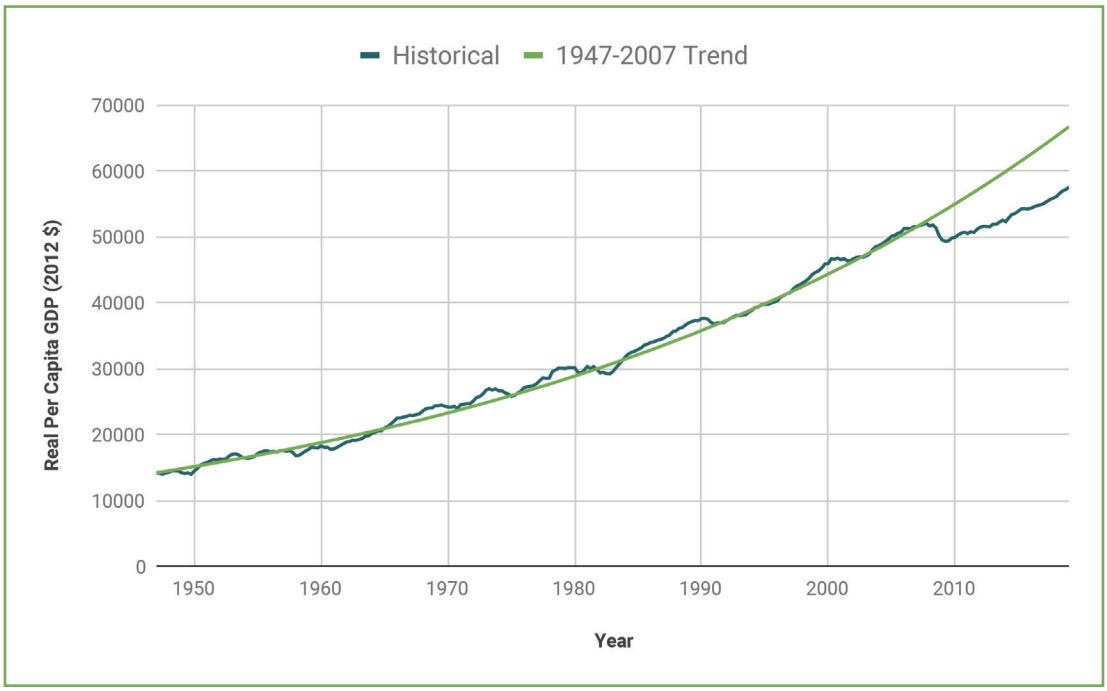
Now let's turn back to the Green New Deal. Suppose that today's 2.5-point gap between growth rates and interest rates is maintained. What kind of debt trajectory would be implied by significantly higher borrowing to fund spending on decarbonization? For concreteness, we will assume 4 percent of GDP additional borrowing, and current GDP growth rates and interest rates. The results are shown in Figure 7.

33 The average rate today is somewhat higher, though still below nominal GDP growth, because the current debt stock includes old debt issued when rates were higher.

FIGURE 7:

Actual and Trend Per-Capita GDP, 1947-2019

Real per-capita GDP and a linear trend based on the period 1947-2007. Prior to 2007, all downturns were followed by a return to trend, but since 2007, the gap between actual GDP and the trend has only gotten wider.



Source: BEA, authors' analysis.

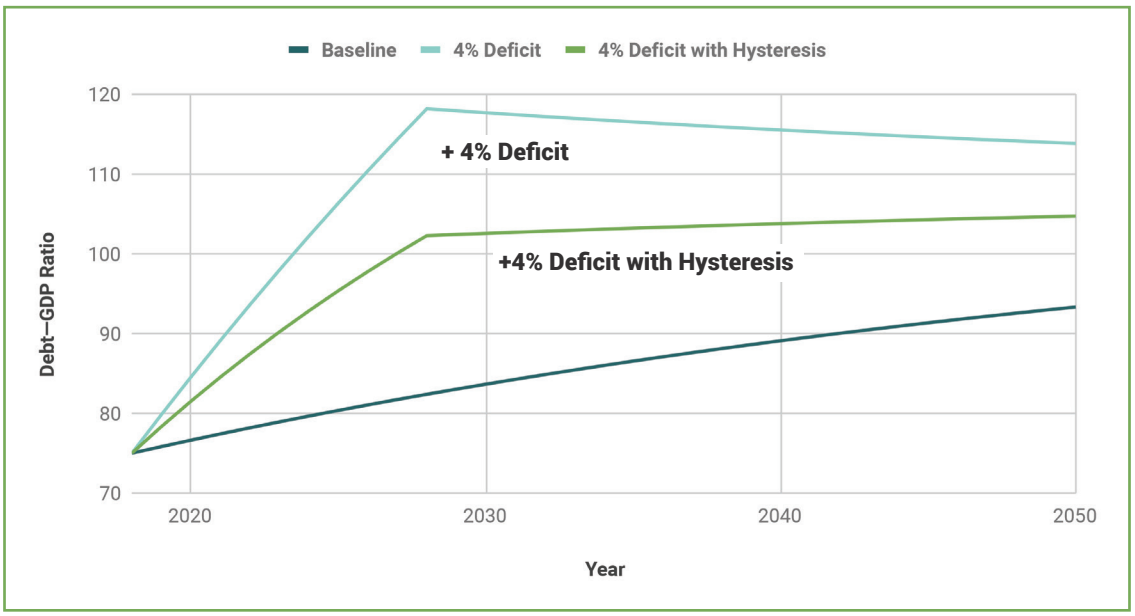
Figure 8 shows three trajectories of the debt-GDP ratio. The first line is the path of the ratio under current policies. (Note, again, that this is different from the forecast of the CBO because, unlike them, we do not assume that interest rates will rise steeply in the future; instead, we assume that they will remain at current levels.) The second shows the effect of additional borrowing equal to 4 percent of GDP, sustained for 10 years. (For simplicity, we have assumed the period of higher spending begins this year, but the results will be very similar if it begins a few years from now.) The third line shows the same scenario, but it now assumes that each point of additional public spending permanently raises GDP by 0.5 points. Two conclusions should be clear from the figure. First, with current interest and growth rates, there is no sense in which a period of even very high deficits places the debt on an unsustainable path. Rather, as soon as the period of high deficits comes to a close, the debt ratio begins to gradually decline—even though, in this scenario, today's primary deficits of 2.7 percent of GDP continue indefinitely. This is a clear visual demonstration of the fact that, in today's environment, increased public debt does not need to be paid down by subsequent surpluses. Second, if increased public spending can boost growth, the rise in the debt ratio will be much less than that suggested by the raw deficit numbers.

We should note here that we are not making a general claim about the effects of deficits on growth. The parameter of 0.5 used here is merely illustrative. That said, it is plausible that public investment and incentives for private investment are more likely to have persistent positive effects on output than many other forms of public spending.

FIGURE 8:

Debt-GDP Ratio Under Various Scenarios

The bottom line shows the future path of the debt-GDP ratio given current interest rates, growth rates, and primary deficit. The top line shows the path given 10 years of additional deficit spending equal to 4 percent of GDP, after which primary deficits return to current levels. The middle line shows the same, but with the assumption that each point of government spending raises potential GDP by half a point.



Source: Authors' analysis.

In the case with no hysteresis, 10 years of additional borrowing equal to 4 percent of GDP brings the debt ratio to 118 percent, after which it gradually declines. In the second case, with strong hysteresis, the debt ratio rises to 103 percent and then stabilizes. These levels, while high, are not unprecedented. At the end of World War II, the US had a debt ratio of 120 percent. If we believe that the urgency of climate change is comparable to the urgency of World War II—a fundamental premise of the Green New Deal—then it is reasonable to contemplate a similar debt ratio. Many other developed countries have seen debt rise even higher relative to GDP, without the soaring interest rates, collapsing exchange rate, or runaway inflation that are the signs of truly excessive debt. Japan's public debt currently stands at 250 percent of GDP. In neither of these cases, nor in other episodes of extremely high debt ratios in developed countries, have we seen the negative macroeconomic effects that high debt ratios are supposed to lead to. (Low-income countries are a different story, especially when they borrow in a foreign currency.) Japan, with the world's highest debt-GDP ratio, continues to maintain extremely low interest rates while struggling with deflation and an exchange rate that is arguably too strong for its manufacturers to export successfully—exactly the opposite of the problems associated with excessive government debt.

Some may argue that today's low-interest environment may not last. But there are good reasons to believe that low interest rates are here for the foreseeable future.

In the first place, there is clearly the judgment of bond-market participants. The fact that bondholders are willing to hold 30-year Treasury bonds at 3 percent shows that they are very confident that rates will not

rise significantly. Even a small chance of a rate increase on the 30-year bonds would imply expected losses greater than the 3 percent yield. The fact that 30- and 10-year rates are quite close is further evidence that market participants don't expect rates to rise. Any interest rate increase would imply larger capital losses on longer bonds, so if market participants thought that higher rates were more likely than lower ones, long bonds would need a higher yield to compensate. The fact that five-, 10-, and 30-year bonds currently trade at almost the same yield is clear evidence that the average bond market participant thinks that a further fall in rates is as likely as an increase. While bond markets are not omniscient, the information embodied in these prices should not be ignored.

In addition, it is important to realize that, historically, interest rates below growth rates are the norm and not the exception. Over the course of the 20th century, GDP growth was, on average, 2.4 points greater than the average interest rate on government debt—almost exactly the gap that exists today. In a longer perspective, it is the high-interest period between 1980 and 2000 that is anomalous. If our default assumption is that the relationship between interest and growth rates going forward will be similar to that which has prevailed historically—as is reasonable—then there is no reason to expect the future interest rate environment to be less favorable to public borrowing than is today's.

In short, there is relatively little reason for concern about the debt-ratio increase even if a large part of the public spending on decarbonization is financed by debt. There may be good reasons, as discussed in the next section, to use a mix of tax and debt financing, rather than to finance all of the increase in public spending with new borrowing. But even if the entire public spending component were financed with debt, there is no reason to believe the debt would be unsustainable.

In short, there is relatively little reason for concern about the debt-ratio increase even if a large part of the public spending on decarbonization is financed by debt.

Taxes

To the extent that it is desirable to use a mix of tax and debt financing rather than pure debt financing, there is certainly space for the federal government to raise taxes. We do not consider carbon taxes or permits as a source of revenue; because of their regressive impact, it is better to rebate those receipts to the public as a carbon dividend. But other Pigouvian taxes may provide substantial revenue.

Pigouvian taxes are taxes on activities with negative externalities (i.e., activities that impose costs on the rest of society). Traditional examples include taxes on polluting industries or on goods with negative impacts on public health, such as alcohol and tobacco. One natural Pigouvian tax to consider is a financial-transactions tax (FTT). While financial transactions are not normally considered a social bad like smoking or air pollution, the manifest failure of speculation-driven financial markets to either deliver stable growth or to channel funds for investment to the most socially desirable uses suggests that they should be. The high incomes available through speculative trading also attract many of the most skilled workers in the economy, with scarce credentials, into unproductive activity in the financial sector.

Reducing incomes there would increase the available supply of scientists, engineers, managers, and other professionals that decarbonization will require. So a financial-transactions tax is a natural complement to the credit policies discussed earlier. An FTT of 0.5 percent on stock and bond transactions and 0.05 percent on derivatives could raise over 1 percent of GDP, depending on how much it reduced trading volumes.

Taxes on the highest levels of income, wealth, and inheritances, while less often discussed in these terms, can also be seen as justified by the social harms caused by the concentration of income and wealth. Sen. Elizabeth Warren's (D-MA) proposed wealth tax is estimated to raise on the order of 1 percent of GDP, or $200 billion per year; a 70 percent tax on incomes over $10 million, as floated by Rep. Alexandria Ocasio-Cortez (D-NY), might raise half of this. Together, these taxes could finance a substantial part of the increased public spending on decarbonization. Equally importantly, these taxes help to safeguard democracy against the outsized power of the wealthiest and to foster a more inclusive, egalitarian society.

If the public financing needs of a Green New Deal were much greater than 5 percent of GDP—for instance, if it incorporated universal health care and a job guarantee—or if there are political obstacles to borrowing on the scale required, then it may be necessary to consider a broader rise in income taxes. This is achievable. Even before the most recent federal tax cuts, the US was the most lightly taxed of large rich countries. As of 2017, taxes for all levels of government—federal, state, and local—totaled only 27 percent of GDP in the US, compared with an average of 34 percent for the Organization for Economic Cooperation and Development (OECD) countries as a group. Among the rich countries, only Ireland, a notorious tax haven, sees a smaller fraction of GDP collected in taxes. In France and several Scandinavian countries, taxes total more than 45 percent of GDP. Thus, even an increase in broad-based taxes on the order of 10 percent of GDP would bring the US only a bit above the OECD average, to around the current level of Germany or the Netherlands.

Such a broad-based tax increase is probably not necessary to finance the types of public spending described in this report. An extremely ambitious decarbonization program could reasonably be financed with a mix of debt and Pigouvian taxes.

The macroeconomic case for a Green New Deal is straightforward. On the one hand, there is overwhelming evidence that the economy's productive potential could support increased spending on decarbonization of at least 5 percent of GDP annually, without the need to crowd out any existing spending. In fact, the demands on real resources of decarbonization—if they take the form of targeted public investment, along with measures to channel credit and private spending—should properly be seen as one of the strongest arguments in favor of a massive program of decarbonization and not as an argument against it. And on the other hand, the financing problem—how to generate the sources of funds equal to the new uses of funds—can be straightforwardly solved with a mix of new debt and targeted tax increases. In an environment of interest rates well below growth rates, and given a plausible case that new public spending would generate significantly faster growth, there is no reason a decarbonization program should require tax increases except where these are desired for their own sake. If a Green New Deal includes broader spending—especially universal health care—as well as decarbonization, financing some part of it with broader income-tax increases is reasonable.

Conclusion

For the past 250 years, industrial societies have relied on fossil fuels as their primary energy source. Unlocking this energy fueled the Industrial Revolution, but we are only now reckoning with the costs associated with our dependence on fossil fuels. There is no doubt that we must rapidly end our reliance on carbon-emitting forms of production today if we want to protect and preserve a livable planet for current and future generations and avoid a catastrophic acceleration of the rising costs of climate change we already face today.

Decarbonizing the United States will require a comprehensive social transformation. It will involve major changes in almost every area of economic life. Some of these changes are obvious, like a rapid end to fossil fuel use for electricity. Others are still unclear, like the best approach to decarbonizing agriculture, and will become clear once society has committed itself to comprehensive decarbonization. All of these changes must happen quickly; we must be well on the way to deep decarbonization within the decade.

Markets have many virtues, but they are poor tools for such a rapid, society-wide reorganization of production. There are many reasons for this. Most obviously, since the costs of climate change are global, they do not factor into the costs considered by private decision-makers. Decentralized decision-making, one of the strengths of markets, makes coordination on an economy-wide scale difficult or impossible—especially when advances in one area (e.g., renewable energy) may both depend on and be the condition for advances in another (e.g., a higher-capacity grid). The pursuit of profit can spur productive innovation—but it can also create incentives for a tenacious defense of existing production processes, when incumbents face the prospect of capital losses on their existing assets. Rapid, large-scale reallocations of resources via markets require very large price changes, which can be disruptive to other activities or simply not possible. Pervasive credit constraints and dysfunctional financial markets can prevent even privately profitable projects from going forward.

For all of these reasons, the public sector must play a leading role in decarbonization. At the same time, prices do have a role to play. One does not need to be a market fundamentalist to agree that some mechanism will be needed to shape the choices families and businesses make between more and less environmentally sustainable forms of spending—in other words, to put a price on carbon. We believe that nontradable permits are a much better tool than taxes to incorporate carbon prices into market decisions.

While we do believe prices have a role to play, it is a supplemental role. Because markets cannot coordinate the rapid, comprehensive economic transformation that decarbonization requires, the leading role must be played by affirmative government programs to direct resources—regulation, public investment, and credit policy. We as a society must decide, democratically but on the basis of professional expertise, which activities and sectors need to expand and which need to shrink or disappear. To do this, we must confront head-on the conventional wisdom of the past 30 years, that says that democratic politics is incapable of making such choices. For decades, we have been told that our governments cannot be trusted. Democracy, we are told, is important within a narrowly defined public realm, but it cannot be trusted to shape our shared economic life. That must happen only through the pursuit of private profit. It is this view that a Green New Deal is most directly challenging.

It is still possible for us as a society, through democratic politics and public debate, informed by climate science, engineering, and economics, to collectively decide how to reshape our economy. We can meet our material needs and extend the promise of material security, while preserving a habitable planet—*if* we deal with our climate crisis through a Green New Deal, and not through market incentives and austerity. It is in this spirit that we present our proposals here—not as a finished blueprint, but as a step forward in the project of collective understanding and action.

There are a handful of key areas that any serious decarbonization proposal must address. First, we must halt fossil fuel extraction. There is no way to avoid catastrophic climate change without leaving most of today's oil and coal reserves in the ground. Next, buildings—the source of nearly 40 percent of US greenhouse gas emissions—must be comprehensively retrofitted, and new buildings must be carbon neutral. The technical side of this is straightforward, drawing on established technologies that allow carbon-neutral or -negative buildings to already go up today. The main challenge is how numerous, widely dispersed, and heterogenous owners and occupants of buildings are. We must also completely electrify the vehicle fleet. Here, again, the technology is established, and with appropriate public incentives and regulations, large-scale adoption should rapidly bring costs down. Norway, where the share of electric vehicles is already over 50 percent, shows what is possible here. Next, we need a much more robust, higher-capacity national grid to overcome the intermittency problem of renewable energy and obviate the need for fossil fuel generation to supply dispatchable power. Buildings, transportation, and power generation account for the majority of carbon emissions. The two other major emitting sectors—agriculture and industry—present greater challenges. To fully decarbonize these sectors, new technologies are likely to be needed, so it is here that a major public investment in research and development is critical. One proven approach in agriculture is carbon capture in the soil, which is important not only as a way of moving toward carbon-neutral agriculture but also as a way of creating income for farmers, who otherwise may bear a disproportionate share of the costs of decarbonization. In every area where investment will be carried out by households or smaller enterprises (such as farms), policies to channel credit will be necessary as well.

In Section 1, we presented policy samples in each of these areas. These are broad proposals; the specifics will be developed through the political process in consultation with experts. We believe, however, that any serious effort to reach carbon neutrality will have to include action in the general areas we have laid out here.

Any serious plan for decarbonization must overcome two pervasive features of the political landscape. First is the skepticism of government that opposes any program for positive government action. This is obvious in the preference for outsourcing, privatization, and delegation of public functions to for-profit businesses—impulses that Green New Deal programs must strenuously resist.

Second, and less visible, is the assumption of scarcity. Conventional environmental economics starts from the assumption that every dollar spent on dealing with climate change is a dollar subtracted from other useful activity, and then asks how we find the right tradeoff. We reject this. It is wrong to assume that our economy normally operates at the limit of its productive capacity, or that it is doing so today. And more broadly, it is wrong to imagine the economic problem in terms of a fixed, known stock of resources. The economy consists of the coordinated activity of millions of people and businesses, all of whom are struggling to find more efficient ways of carrying out their work under the constraints imposed by markets. It is a creative, open-ended process in which people can learn new and better ways of working together, in which people's latent capacities can be developed if conditions are favorable. The record of history—from industrialization to the mobilization for World War II to the internet boom—tells us that when conditions are favorable, when demand is strong, and when government solves the high-level coordination problems, people can rapidly find new solutions to economic problems that had previously seemed intractable. Boom conditions, when labor is scarce and demand is strong, can call forth rapid increases in productivity, as new technologies become worth deploying.

The Green New Deal called for by activists and legislators is a broad vision for a more equitable economy, with a much more active role for the government. But decarbonization is at the core of this vision. Decarbonization is essential to preserving a habitable planet; it is also the spur and organizing principle that will allow the public sector to be mobilized to solve our other pressing economic problems, and the private economy to be pushed to its limits. It is the moral equivalent of war. A crash program of decarbonization will shatter the conventional wisdom that says that big problems—climate change, but also universal access to health care, higher education and housing; the domination of the productive economy by finance; the decline of the labor movement and the proliferation of unrewarding, insecure jobs—are too hard for government to solve. The Green New Deal is more than decarbonization, but there can be no Green New Deal without it.

Decarbonization is essential to preserving a habitable planet; it is also the spur and organizing principle that will allow the public sector to be mobilized to solve our other pressing economic problems, and the private economy to be pushed to its limits.

Many of the specifics of decarbonization can only be determined along the way, as the true landscape of technical and political possibilities becomes clearer. But to defer a commitment to decarbonization until all the specifics are filled in is a recipe for endless inaction. Only through bold experimentation will we discover what we are really capable of.

The great problem of the 21st century is climate change. But meeting this challenge is also an opportunity. It is the spur we may need to unleash the public and private spending necessary to mobilize the vast but underused productive capacities of our workers and businesses. And it offers us a chance to reclaim our collective power and reshape our society into one that is more just and equitable—one more focused on human flourishing and less on private profit. We should not let this chance go to waste.

References

Aas, Dan, and Michael O'Boyle. 2016. "Moving Toward Value in Utility Compensation." America's Power Plan. https://americaspowerplan.com/wp-content/uploads/2016/08/2016_Aas-OBoyle_Reg-Alternatives.pdf.

Abergel, Thibaut, Brian Dean, John Dulac, and Ian Hamilton. 2018. "2018 Global Status Report: Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector." Global Alliance for Buildings and Construction. https://www.worldgbc.org/sites/default/files/2018%20GlobalABC%20Global%20Status%20Report.pdf.

Abraham, Spencer. 2002. "National Transmission Grid Study." Washington, DC: US Department of Energy. https://www.energy.gov/sites/prod/files/oeprod/DocumentsandMedia/TransmissionGrid.pdf.

Ackerman, Frank. 2019. "Methane Measurements and Short Attention Spans." *Triple Crisis* (blog), February 18, 2019. http://triplecrisis.com/methane-measurements-and-short-attention-spans/.

Advanced Research Projects Agency-Energy (ARPA-E). 2016. "FY 2017 Congressional Budget Justification." Washington, DC: ARPA-E. https://arpa-e.energy.gov/sites/default/files/ARPA-E%20FY17%20Budget%20Request.pdf.

Advanced Research Projects Agency-Energy (ARPA-E). 2017. "ARPA-E Impact." Last updated March 2019. https://arpa-e.energy.gov/?q=site-page/arpa-e-impact.

Aldy, Joseph E. 2013. "Eliminating Fossil Fuel Subsidies." Washington, DC: The Hamilton Project. https://www.brookings.edu/wp-content/uploads/2016/06/THP_15WaysFedBudget_Prop5.pdf.

Alperovitz, Gar, and Johanna Bozuwa. 2019. "Electric Companies Won't Go Green Unless the Public Takes Control." *In These Times*, April 22, 2019. http://inthesetimes.com/features/green-new-deal-solar-power-local-control.html.

American Public Transportation Association (APTA). 2017. "January Transit Savings Report." January 27, 2017. Washington, DC: APTA. https://www.catchacat.org/apta-january-transit-savings-report-2/.

American Public Transportation Association (APTA). 2018. "2017 Public Transportation Fact Book." Washington, DC: APTA. https://www.apta.com/wp-content/uploads/2017-APTA-Fact-Book.pdf.

American Society of Civil Engineers (ASCE). 2016. "Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future." Reston, VA: ASCE. https://www.infrastructurereportcard.org/wp-content/uploads/2016/10/ASCE-Failure-to-Act-2016-FINAL.pdf.

Anzoategui, Diego, Diego Comin, Mark Gertler, and Joseba Martinez. 2016. "Endogenous Technology Adoption and R&D as Sources of Business Cycle Persistence." Working Paper no. 22005. NBER Working Paper Series. Cambridge, MA: National Bureau of Economic Research. https://www.nber.org/papers/w22005.

Arieff, Allison. 2018. "Automated Vehicles Can't Save Cities." *New York Times*, February 27, 2018, sec. Opinion. https://www.nytimes.com/interactive/2018/02/27/opinion/automated-vehicles-cant-save-cities.html.

Aronoff, Kate. 2018. "The Fossil Fuel Industry Spent $100 Million to Kill Green Ballot Measures in Three States – and Won." *Intercept*, November 7, 2018. https://theintercept.com/2018/11/07/midterm-elections-green-ballot-measures-fossil-fuel/.

Athalye, Rahul Anand, Deepak Sivaraman, D.B. Elliott, Bing Liu, and Rosemarie Bartlett. 2016. "Impacts of Model Building Energy Codes." Richland, WA: Pacific Northwest National Laboratory. https://www.energycodes.gov/sites/default/files/documents/Impacts_Of_Model_Energy_Codes.pdf.

Azoulay, Pierre, Erica Fuchs, Anna Goldstein, and Michael Kearney. 2018. "Funding Breakthrough Research: Promises and Challenges of the 'ARPA Model.'" Working Paper no. 24674. NBER Working Paper Series. Cambridge, MA: National Bureau of Economic Research. https://www.nber.org/papers/w24674.

Baker, James A., Martin Feldstein, Ted Halstead, N. Gregory Mankiw, Henry M. Paulson Jr., George P. Shultz, Thomas Stephenson, Rob Walton. 2017. "The Conservative Case for Carbon Dividends." Climate Leadership Council. https://www.clcouncil.org/media/2017/03/The-Conservative-Case-for-Carbon-Dividends.pdf.

Ball, Laurence. 2009. "Hysteresis in Unemployment: Old and New Evidence." Working Paper no. 14818. NBER Working Paper Series. Cambridge, MA: National Bureau of Economic Research. https://www.nber.org/papers/w14818.

Ball, Laurence. 2015. "Monetary Policy for a High-Pressure Economy." Washington, DC: Center on Budget and Policy Priorities. http://www.econ2.jhu.edu/People/Ball/HighPressure.pdf.

Barbier, Edward B. 2010. *A Global Green New Deal*. New York: Cambridge University Press.

Barbose, Galen. 2015. "U.S. Renewable Portfolio Standards: Overview of Status and Key Trends" (PowerPoint presentation, 2015 National Summit on RPS, Washington, DC, November 5, 2015). https://www.cesa.org/assets/2015-Files/RPS-Summit/Galen-Barbose-11.5.15.pdf.

Barnes, Peter. 2014. *With Liberty and Dividends for All: How to Save Our Middle Class When Jobs Don't Pay Enough*. San Francisco: Berrett-Koehler Publishers.

Barnichon, Regis, Christian Matthes, and Alexander Ziegenbein. 2018. "The Financial Crisis at 10: Will We Ever Recover?" FRBSF Economic Letter. San Francisco, CA: Federal Reserve Bank of San Francisco. https://www.frbsf.org/economic-research/publications/economic-letter/2018/august/financial-crisis-at-10-years-will-we-ever-recover/.

Baron, Richard, and David Fischer. 2015. "Divestment and Stranded Assets in the Low-Carbon Transition" (background paper for 32nd Round Table on Sustainable Development, Paris, October 28, 2015). https://www.oecd.org/sd-roundtable/papersandpublications/Divestment%20and%20Stranded%20Assets%20in%20the%20Low-carbon%20Economy%2032nd%20OECD%20RTSD.pdf.

Beachy, Ben. 2016. "Discussion Paper: A New, Climate-Friendly Approach to Trade." Oakland, CA: Sierra Club. https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org.creative-archive/files/pdfs/1433%20New%20Trade%20Report%2005_low.pdf.

Berg, Weston, Seth Nowak, Grace Relf, Shruti Vaidyanathan, Eric Junga, Marianne DiMascio, and Emma Cooper. 2018. "The 2018 State Energy Efficiency Scorecard." Washington, DC: American Council for an Energy-Efficient Economy. https://aceee.org/research-report/u1808.

Bivens, Josh. 2019. "The Fed Shouldn't Give up on Restoring Labor's Share of Income - and Measure It Correctly" *Economics Policy Institute Working Economics Blog*. January 30, 2019. https://www.epi.org/blog/the-fed-shouldnt-give-up-on-restoring-labors-share-of-income-and-measure-it-correctly/.

Bivens, Josh, and Ben Zipperer. 2018. "The Importance of Locking in Full Employment for the Long Haul." Washington, DC: Economic Policy Institute. https://www.epi.org/files/pdf/147755.pdf.

Blanchard, Olivier. "Public Debt and Low Interest Rates." *American Economic Review*. https://www.aeaweb.org/aea/2019conference/program/pdf/14020_paper_etZgfbDr.pdf.

Blanchard, Olivier. 2018. "Should We Reject the Natural Rate Hypothesis?" *Journal of Economic Perspectives* 32, no. 1 (Winter): 97–120. https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.32.1.97.

Bloom, Aaron. 2018. "Interconnections Seam Study" (PowerPoint presentation, TransGrid-X Symposium, Ames, Iowa, July 26, 2018). https://www.terrawatts.com/seams-transgridx-2018.pdf.

Board of Governors of the Federal Reserve System. 2018. "Report on the Economic Well-Being of U.S. Households in 2017." Washington, DC: Board of Governors of the Federal Reserve System. https://www.federalreserve.gov/publications/files/2017-report-economic-well-being-us-households-201805.pdf.

Board of Governors of the Federal Reserve System. 2019. "Capacity Utilization: Total Industry." FRED, Federal Reserve Bank of St. Louis. Last updated May 15, 2019. https://fred.stlouisfed.org/graph/?g=ncOk.

Boyce, James K. 2007. "Is Inequality Bad for the Environment?" in *Research in Social Problems and Public Policy*, Vol. 15, *Equity and the Environment*, edited by Robert C. Wilkinson and William R. Freudenburg, 267-88 . Bingley, UK: Emerald Group Publishing Limited.

Boyce, James K. 2017. "The Humble Economist: What Economics Can—and Can't—Tell Us About Climate Change." (draft paper for INET Plenary Conference, Edinburgh, October 21-23, 2017). https://www.ineteconomics.org/uploads/papers/BoyceConferencePaper.pdf.

Boyce, James K. 2018. "Carbon Pricing: Effectiveness and Equity." *Ecological Economics* 150 (August): 52-61. https://www.sciencedirect.com/science/article/pii/S092180091731580X?via%3Dihub.

Britton-Purdy, Jedediah. 2018. "The World We've Built." *Dissent*, July 3, 2018. https://www.dissentmagazine.org/online_articles/world-we-built-sovereign-nature-infrastructure-leviathan.

Bureau of Labor Statistics. 2019a. "Civilian Labor Force Participation Rate." FRED, Federal Reserve Bank of St. Louis. Last updated May 3, 2019. https://fred.stlouisfed.org/series/CIVPART.

Bureau of Labor Statistics. 2019b. "Civilian Employment-Population Ratio." FRED, Federal Reserve Bank of St. Louis. Last updated May 3, 2019. https://fred.stlouisfed.org/series/EMRATIO.

Bureau of Labor Statistics. 2019c. "Civilian Labor Force Participation Rate.: 25 to 54 Years" FRED, Federal Reserve Bank of St. Louis. Last updated May 3, 2019. https://fred.stlouisfed.org/graph/?g=ncOe.

Bureau of Transportation Statistics (BTS). 2018. "Transportation Economic Trends." Washington, DC: BTS. https://www.bts.gov/product/transportation-economic-trends.

Burke, Marshall, W. Matthew Davis, and Noah S. Diffenbaugh. 2018. "Large Potential Reduction in Economic Damages under UN Mitigation Targets." *Nature* 557, no. 7706: 549-53. https://www.nature.com/articles/s41586-018-0071-9.

CA Energy Commission and CA Public Utilities Commission. 2015. "New Residential Zero Net Energy Action Plan 2015-2020." http://www.cpuc.ca.gov/general.aspx?id=10740.

Cagle, Susie. 2019. "This Is Why California Will Keep Burning." *Vice*, April 17, 2019. https://www.vice.com/en_us/article/qvygeq/this-is-why-california-will-keep-burning.

Caiazzo, Fabio, Akshay Ashok, Ian A. Waitz, Steve H.L. Yim, and Steven R.H. Barrett. 2013. "Air Pollution and Early Deaths in the United States. Part I: Quantifying the Impact of Major Sectors in 2005." *Atmospheric Environment* 79 (November): 198-208.

California Climate & Agriculture Network (CalCAN). n.d. "Healthy Soils Program." CalCAN. Accessed May 30, 2019. http://calclimateag.org/hsp/.

Cal. Pub. Res. Code § 25403 (Deering 2019).

Carbon Pricing Leadership Coalition. n.d. "Carbon Pricing Dashboard." Accessed June 4, 2019. https://www.carbonpricingleadership.org/who.

Carbon Pricing Leadership Coalition. 2017. "Report of the High-Level Commission on Carbon Prices." Washington, DC: Carbon Pricing Leadership Coalition. https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59244eed17bffc0ac256cf16/1495551740633/CarbonPricing_Final_May29.pdf.

Carlson, Mark, and Burcu Duygan-Bump. 2016. "The Tools of Transmission of Federal Reserve Monetary Policy in the 1920s." FEDS Notes. Washington, DC: Board of Governors of the Federal Reserve System. https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/tools-and-transmission-of-federal-reserve-monetary-policy-in-the-1920s-20161122.html.

Channell, Jason, Elizabeth Curmi, Phuc Nguyen, Elaine Prior, Alastair R. Syme, Heath R. Jansen, Ebrahim Rahbari, Edward L. Morse, Seth M. Kleinman, and Tim Kruger. 2015. "Energy Darwinism II." Citi GPS: Global Perspectives & Solutions. https://ir.citi.com/hsq32Jl1m4aIzicMqH8sBkPnbsqfnwy4Jgb1J2kIPYWIw5eM8yD3FY9VbGpK%2Baax.

Chester, Mikhail, and Arpad Horvath. 2009. "Life-Cycle Energy and Emissions Inventories for Motorcycles, Diesel Automobiles, School Buses, Electric Buses, Chicago Rail, and New York City Rail." Berkeley: UC Berkeley Center for Future Urban Transport. http://escholarship.org/uc/item/6z37f2jr.

Chodorow-Reich, Gabriel. 2014. "The Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008-9 Financial Crisis." *Quarterly Journal of Economics* 129, no. 1 (February): 1-59. https://academic.oup.com/qje/article/129/1/1/1899226.

Choi Granade, Hannah, Jon Creyts, Anton Derkach, Philip Farese, Scott Nyquist, and Ken Ostrowski. "Unlocking Energy Efficiency in the U.S. Economy." McKinsey Global Energy and Materials. McKinsey & Company. https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/epng/pdfs/unlocking%20energy%20efficiency/us_energy_efficiency_exc_summary.ashx.

Chu, Hong-Hanh, Benjamin Miller, Kurt Gaertner, Deirdre Buckley, Eve Schluter, Sharon Weber, Will Space, et al. 2019. "Global Warming Solutions Act 10-Year Progress Report." Boston: Commonwealth of Massachusetts. https://www.mass.gov/files/documents/2019/04/02/GWSA-10-Year-Progress-Report.pdf.

Climate Leadership Council (CLC). 2019. "Economists' Statement on Carbon Dividends." *Wall Street Journal,* January 16, 2019. https://www.wsj.com/articles/economists-statement-on-carbon-dividends-11547682910.

Coady, David, Ian Parry, Louis Sears, and Baoping Shang. 2017. "How Large are Global Fossil Fuel Subsidies?" *World Development* 91, no. 1 (March): 11-27. https://www.sciencedirect.com/science/article/abs/pii/S0305750X16304867?via%3Dihub.

Congressional Budget Office (CBO). 2001. "An Evaluation of Cap-and-Trade Programs for Reducing U.S. Carbon Emissions." Washington, DC: CBO. https://www.cbo.gov/sites/default/files/107th-congress-2001-2002/reports/captrade.pdf.

Crooks, Ed. 2019. "US Court Halts Drilling in Wyoming Over Climate Change." *Financial Times*, March 20, 2019. https://www.ft.com/content/24005406-4b32-11e9-8b7f-d49067e0f50d.

Danko, Pete. 2018. "Portland Fossil-Fuel Infrastructure Ban Survives Court Challenge." *Portland Business Journal*, August 1, 2018. https://www.bizjournals.com/portland/news/2018/08/01/portland-fossil-fuel-infrastructure-ban-survives.html.

Dantas, Flavia, and L. Randall Wray. 2017. "Full Employment: Are We There Yet?" Public Policy Brief no. 142. Annandale-on-Hudson: Levy Economics Institute of Bard College. http://www.levyinstitute.org/pubs/ppb_142.pdf.

D'Arista, Jane, and James Boyce. 2002. "Where Credit is Due: Allocating Credit to Advance Environmental Goals." *Challenge* 45, no. 3: 58-82. https://www.tandfonline.com/doi/abs/10.1080/05775132.2002.11034150.

De Grauwe, Paul, and Yuemei Ji. 2019. "Inflation Targets and the Zero Lower Bound in a Behavioural Macroeconomic Model." *Economica* 86, no. 342 (April): 262-99. https://onlinelibrary.wiley.com/doi/full/10.1111/ecca.12261.

Dennis, Keith, Ken Colburn, and Jim Lazar. 2016. "Environmentally Beneficial Electrification: The Dawn of 'Emissions Efficiency.'" *Electricity Journal* 29, no. 6 (July): 52-58. https://www.researchgate.net/publication/306324505_Environmentally_beneficial_electrification_The_dawn_of_'emissions_efficiency'.

Department of Energy (DOE). 2017. "U.S Energy and Employment Report." Washington, DC: DOE. https://www.energy.gov/sites/prod/files/2017/01/f34/2017%20US%20Energy%20and%20Jobs%20Report_0.pdf.

Department of Energy (DOE). 2018. "Status of State Energy Code Adoption." Last updated December 2018. https://www.energycodes.gov/status-state-energy-code-adoption.

Department of Energy (DOE). 2019. "All-Electric Vehicles." Accessed May 30, 2019. https://fueleconomy.gov/feg/evtech.shtml.

Dinakaran, Chandni. 2018. "Mapping Carbon Pricing Around the World." *Carbon Pricing Leadership Coalition* (blog), November 5, 2018. https://www.carbonpricingleadership.org/blogs/2018/11/5/mapping-out-carbon-pricing-around-the-world.

The Economist. 2017. "China Powers Head with a New Direct-Current Infrastructure." January 16, 2017.

Edwards, Scott. 2018. "No, Carbon Taxes Aren't Socialist." *Jacobin*, October 10, 2018. https://www.jacobinmag.com/2018/10/carbon-taxes-climate-change-united-nations-report.

Eichholtz, Piet M., Nils Kok, and John M. Quigley. 2013. "The Economics of Green Building." *Review of Economics and Statistics* 95, no. 1 (March): 50-63. https://www.researchgate.net/publication/254396180_The_Economics_of_Green_Building.

Energy Information Administration (EIA). 2016. 2012 CBECS Survey Data. https://www.eia.gov/consumption/commercial/data/2012/bc/pdf/b1-b46.pdf.

Energy Information Administration (EIA). 2017. "U.S. Household Spending for Gasoline Is Expected to Remain Below $2,000 in 2017." *Today in Energy* (blog), October 6, 2017. https://www.eia.gov/todayinenergy/detail.php?id=33232.

Energy Information Administration (EIA). 2018a. "Energy and the Environment Explained: Where Greenhouse Gases Come From." Last updated July 20, 2018. https://www.eia.gov/energyexplained/index.php?page=environment_where_ghg_come_from.

Energy Information Administration (EIA). 2018b. "How Much Energy Is Consumed in U.S. Residential and Commercial buildings?" Frequently Asked Questions. Last updated May 14, 2019. https://www.eia.gov/tools/faqs/faq.php?id=86&t=1.

Energy Information Administration (EIA). 2018c. "Residential Energy Consumption Survey (RECS)." https://www.eia.gov/consumption/residential/data/2015/hc/php/hc2.1.php.

Energy Information Administration (EIA). 2019a. "What is U.S. Electricity Generation by Energy Source?" Frequently Asked Questions. Last updated March 1, 2019. https://www.eia.gov/tools/faqs/faq.php?id=427&t=3.

Energy Information Administration (EIA). 2019b. "Crude Oil Production." Petroleum & Other Liquids. Last updated April 30, 2019. https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_a.htm.

Engel, Hauke, Russell Hensley, Stefan Knupfer, and Shivika Sahdev. 2018. "Charging Ahead: Electric-Vehicle Infrastructure Demand." McKinsey and Company, August 2018, updated October 2018. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/charging-ahead-electric-vehicle-infrastructure-demand.

Environmental Protection Agency (EPA) . n.d. "Sources of Greenhouse Gas Emissions." Accessed May 30, 2019. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

Environmental Protection Agency (EPA). 2018a. "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2017." Washington, DC: EPA. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100TGDW.pdf.

Environmental Protection Agency (EPA). 2018b. "Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions 1990-2016." Accessed May 30, 2019. https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.

Environmental Protection Agency (EPA). 2019. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017." Washington, DC: EPA. https://www.epa.gov/sites/production/files/2019-04/documents/us-ghg-inventory-2019-chapter-executive-summary.pdf.

Erickson, Peter, Adrian Down, Michael Lazarus, and Doug Koplow. 2017. "Effect of Subsidies to Fossil Fuel Companies on United States Crude Oil Production." *Nature Energy* 2, no. 11: 891-98. https://www.nature.com/articles/s41560-017-0009-8.

Eubanks, Virginia. 2016. "My Drowning City Is a Harbinger of Climate Slums to Come." *The Nation*, August 29, 2016. https://www.thenation.com/article/low-water-mark/.

Fatás, A., and Lawrence H. Summers. 2018. "The Permanent Effects of Fiscal Consolidations." *Journal of International Economics* 112 (May): 238-50. https://www.sciencedirect.com/science/article/pii/S0022199617301411.

Fowlie, Meredith, Michael Greenstone, and Catherine Wolfram. 2018. "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program." *Quarterly Journal of Economics* 133, no. 3 (August): 1597-644. https://academic.oup.com/qje/article-abstract/133/3/1597/4828342?redirectedFrom=fulltext.

Fremstad, Anders, and Mark Paul. 2017. "Economic Impact of the California Global Warming Solutions Act (SB-775) on CA Households." Self-published. https://markpaulecon.files.wordpress.com/2017/07/ca-sb775-report1.pdf.

Fremstad, Anders, and Mark Paul. 2018. "Disrupting the Dirty Economy." Washington, DC: People's Policy Project. https://www.peoplespolicyproject.org/wp-content/uploads/2018/09/CarbonTax.pdf.

Fremstad, Anders, and Mark Paul. 2019. "The Impact of a Carbon Tax on Inequality." Ecological Economics 163 (September): 88-97. https://www.sciencedirect.com/science/article/pii/S092180091831084X?via%3Dihub.

Friedlander, Gordon D. 1968. "Prevention of Power Failures. The FPC Report of 1967." *IEEE Spectrum* 5 (2): 53-61.

Fulton, Lew, Jacob Mason, and Dominique Meroux. 2017. "Three Revolutions in Urban Transportation." Institute for Transportation and Development Policy and UC Davis Institute of Transportation Studies. https://3gozaa3xxbpb499ejp30lxc8-wpengine.netdna-ssl.com/wp-content/uploads/2017/04/ITDP-3R-Report-FINAL.pdf.

Furman, Jason. 2015. "Trends in Labor Force Participation." Executive Office of the President of the United States (PowerPoint presentation, National Press Club, Washington, DC, August 6, 2015). https://obamawhitehouse.archives.gov/sites/default/files/docs/20150806_labor_force_participation_retirement_research_consortium.pdf.

Furman, Jason. 2016. "The New View of Fiscal Policy and Its Application." Expanded version of address delivered at Global Implications of Europe's Redesign conference. New York. October 5, 2016. https://obamawhitehouse.archives.gov/sites/default/files/page/files/20161005_furman_suerf_fiscal_policy_cea.pdf.

Furman, Jason, and Lawrence H. Summers. 2019. "Who's Afraid of Budget Deficits? How Washington Should End Its Debt Obsession." *Foreign Affairs.* March/April 2019. https://www.foreignaffairs.com/articles/2019-01-27/whos-afraid-budget-deficits.

Gerarden, Todd D., Richard G. Newell, and Robert N. Stavins. 2017. "Assessing the Energy-Efficiency Gap." *Journal of Economic Literature* 55, no. 4: 1486-525. https://pubs.aeaweb.org/doi/pdf/10.1257/jel.20161360.

Georgetown Climate Center. n.d. "State and Local Adaptation Plans." Accessed May 30, 2019. https://www.georgetownclimate.org/adaptation/plans.html.

Gewin, Virginia. 2019. "New Market Planned to Pay Farmers for Soil Carbon, Water Quality." *Successful Farming,* March 6, 2019. https://www.agriculture.com/news/business/new-market-planned-to-pay-farmers-for-soil-carbon-water-quality.

Gillingham, Kenneth, and Karen Palmer. 2014. "Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence." *Review of Environmental Economics and Policy* 8, no. 1 (Winter): 18-38. https://www.researchgate.net/publication/256045327_Bridging_the_Energy_Efficiency_Gap_Policy_Insights_from_Economic_Theory_and_Empirical_Evidence.

Girardi, Daniele, Walter Paternesi Meloni, and Antonella Stirati. 2018. "Persistent Effects of Autonomous Demand Expansions." Working Paper no. 70. Institute for New Economic Thinking . https://www.ineteconomics.org/research/research-papers/persistent-effects-of-autonomous-demand-expansions.

Global Change Research Program. 2018. "Fourth National Climate Assessment." Washington, DC: US Global Change Research Program. https://www.globalchange.gov/nca4.

Goetzler, William, Timothy Sutherland, Rahul Kar, and Kevin Foley. 2011. "Comparison of Real World Energy Consumption to Models and Department of Energy Test Procedures." Prepared by Navigant Consulting, Inc. for the US Department of Energy. https://www.energy.gov/sites/prod/files/2014/07/f17/real_world_energy_comparison.pdf.

Golden, Rachel. 2018. "California Invests $50 Million in Healthy All-Electric Homes for San Joaquin Valley Communities." *Sierra Club* (blog), December 13, 2018. https://www.sierraclub.org/articles/2018/12/california-invests-50-million-healthy-all-electric-homes-for-san-joaquin-valley.

Gouldson, Andy, Colenbrander, Sarah, Sudmant, Andrew, Godfrey, Nick, Millward-Hopkins, Joel, Fang, Wanli, and Zhao, Xiao. 2015. "Accelerating Low-Carbon Development in the World's Cities." London and Washington, DC: New Climate Economy. https://newclimateeconomy.report/2015/wp-content/uploads/sites/3/2015/09/NCE2015_workingpaper_cities_final_web.pdf.

Goulder, Lawrence, and Marc Hafstead. 2013. "Tax Reform and Environmental Policy: Options for Recycling Revenue from a Tax on Carbon Dioxide." Discussion Paper 13-31. Washington, DC: Resources for the Future. https://www.rff.org/publications/working-papers/tax-reform-and-environmental-policy-options-for-recycling-revenue-from-a-tax-on-carbon-dioxide/.

Government Accountability Office (GAO). 2007. "Energy Efficiency: Long-Standing Problems with DOE's Program for Setting Energy Efficiency Standards Continue to Result in Forgone Energy Savings." Washington, DC: GAO. https://www.gao.gov/assets/260/256229.pdf.

Gowan, Peter. 2018. "A Plan to Nationalize Fossil-Fuel Companies." *Jacobin*, March 26, 2018. https://www.jacobinmag.com/2018/03/nationalize-fossil-fuel-companies-climate-change.

Grabar, Henry. 2016. "Why the Feds Protect Some Towns From Flooding and Leave Others Exposed." *Slate,* December 7, 2016. http://www.slate.com/blogs/moneybox/2016/12/07/why_the_feds_let_some_neighborhoods_flood.html.

The Greenhouse Effect: Impacts on Current Global Temperature and Regional Heat Waves, before Sen. Comm. on Energy and Natural Resources, 100th Cong. (1988) (statement of James E. Hansen, NASA Goddard Institute for Space Studies). https://climatechange.procon.org/sourcefiles/1988_Hansen_Senate_Testimony.pdf.

Greenpeace. n.d. "Keep It in the Ground." Accessed May 30, 2019. https://www.greenpeace.org/usa/global-warming/keep-it-in-the-ground/.

Harvey, Hal, Robbie Orvis, and Jeffrey Rissman. 2018. *Designing Climate Solutions: A Policy Guide for Low-Carbon Energy*. Washington, DC: Island Press.

Hersher, Rebecca, and Robert Benincasa. 2019. "How Federal Disaster Money Favors The Rich." *NPR*, March 5, 2019. https://www.npr.org/2019/03/05/688786177/how-federal-disaster-money-favors-the-rich?utm_campaign=storyshare&utm_source=twitter.com&utm_medium=social.

Hirji, Zahra. 2016. "Portland Bans New Fossil Fuel Infrastructure in Stand Against Climate Change." *Inside Climate* News, December 15, 2016. https://insideclimatenews.org/news/14122016/portland-oregon-ban-fossil-fuels-oil-and-gas-pipelines-coal-global-warming.

Hodges, Tina. 2010. "Public Transportation's Role in Responding to Climate Change." Washington, DC: US Department of Transportation . https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf.

Hook, Leslie. 2019. "Surge in US Economists' Support for Carbon Tax to Tackle Emissions." *Financial Times*, February 17, 2019. https://www.ft.com/content/fa0815fe-3299-11e9-bd3a-8b2a211d90d5?utm_source=dlvr.it&utm_medium=twitter.

Howard, Philip H. 2016. *Concentration and Power in the Food System: Who Controls What We Eat?* London: Bloomsbury Academic.

Hsiang, Solomon, Robert Kopp, Amir Jina, James Rising, Michael Delgado, Shashank Mohan, D. J. Rasmussen, et al. 2017. "Estimating Economic Damage from Climate Change in the United States." Science 356, no. 6345: 1362-69. https://science.sciencemag.org/content/356/6345/1362.

Huber, Matt. 2016. "The Carbon Tax is Doomed." *Jacobin*, October 9, 2016. https://www.jacobinmag.com/2016/10/oil-fossil-fuel-climate-cap-trade-tax-renewables/.

Initiative on Global Markets. 2012. "Carbon Taxes II." IGM Forum. December 4, 2012. http://www.igmchicago.org/surveys/carbon-taxes-ii.

Institute for Market Transportation (IMT). 2017. "2017 National Green Building Adoption Index." Washington, DC: IMT. https://dimension.maps.arcgis.com/apps/MapJournal/index.html?appid=a835df78ffe64a92be638610132b9b95#.

Intergovernmental Panel on Climate Change (IPCC). 2018. "Summary for Policymakers," in *Global Warming of 1.5°C*, ed.V. Masson-Delmotte, V., P. Zhai, H. -O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al.. Geneva: IPCC.

International Council on Clean Transportation (ICCT). 2019. "Chart Library: Passenger Vehicle Fuel Economy." Accessed May 30, 2019. https://www.theicct.org/chart-library-passenger-vehicle-fuel-economy.

Jacobson, Mark Z., Mark A. Delucchi, Guillaume Bazouin, Zack A.F. Bauer, Christa C. Heavey, Emma Fisher, Sean B. Morris, Diniana J.Y. Piekutowski, Taylor A. Vencill, and Tim W. Yeskoo. 2015. "100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for the 50 United States." *Energy & Environmental Science* 8, no. 7: 2093-117. https://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf.

Jewell, Jessica, David McCollum, Johannes Emmerling, Christoph Bertram, David E. H. J. Gernaat, Volker Krey, Leonidas Paroussos, et al. 2018. "Limited Emission Reductions from Fuel Subsidy Removal Except in Energy-Exporting Regions." *Nature* 554 (February): 229-33. https://www.nature.com/articles/nature25467.

Jorgenson, Dale W., Richard J. Goettle, Mun S. Ho, and Peter J. Wilcoxen. 2015. "Carbon Taxes and Fiscal Reform in the United States." *National Tax Journal*, 68, no. 1: 121-38. https://www.researchgate.net/publication/273276384_Carbon_Taxes_and_Fiscal_Reform_in_the_United_States.

J.P. Morgan. 2018. "Driving into 2025: The Future of Electric Vehicles." October 10, 2018. https://www.jpmorgan.com/global/research/electric-vehicles.

Katznelson, Ira. 2005. *When Affirmative Action Was White: An Untold History of Racial Inequality in Twentieth-Century America*. New York: W.W. Norton & Company.

Kaufman, Alexander C., and Chris D'Angelo. 2019. "Oil Giants Invest $110 Billion in New Fossil Fuels After Spending $1 Billion on Green PR." *Huffington Post*, March 21, 2019. https://www.huffpost.com/entry/oil-industry-climate_n_5c940962e4b0a6329e144e6c.

Kavlak, Goksin, James McNerney, and Jessika E. Trancik. 2018. "Evaluating the Causes of Cost Reduction in Photovoltaic Modules." *Energy Policy* 123, no. 1(December): 700-10. https://www.sciencedirect.com/science/article/pii/S0301421518305196.

Kębłowski, Wojciech. 2018. "Public Transport Can Be Free." *Jacobin*, August 24, 2018. https://www.jacobinmag.com/2018/08/public-transportation-brussels-free-tickets.

Klein, Naomi. 2014. *This Changes Everything: Capitalism vs. the Climate*. New York: Simon & Schuster.

Klein, Naomi. 2016. "The Carbon Tax on the Ballot in Washington State Is Not the Right Way to Deal with Global Warming." *Nation*, November 4, 2016. https://www.thenation.com/article/the-carbon-tax-on-the-ballot-in-washington-state-is-not-the-right-way-to-deal-with-global-warming/.

Koeppel, Jackson, Johanna Bozuwa, and Liz Veazey. 2019. "Policy Proposal: Community Ownership of Power Administration (COPA)" Washington DC: The Next System Project). https://thenextsystem.org/sites/default/files/2019-03/COPA%20policy%20proposal%20fact%20sheet.pdf.

Konczal, Mike. 2018. "How Low Can Unemployment Go? Economists Keep Getting the Answer Wrong." *Vox,* May 5, 2018. https://www.vox.com/the-big-idea/2018/5/4/17320188/jobs-report-natural-rate-unemployment-inflation-economics-april.

Lawrence Livermore National Laboratory. n.d. "Energy Flow Charts, 2017: United-States." Accessed June 4, 2019. https://flowcharts.llnl.gov/commodities/energy.

Leaton, James. 2011. "Unburnable Carbon: Are the World's Financial Markets Carrying a Carbon Bubble?" London: Carbon Tracker Initiative. https://www.carbontracker.org/reports/carbon-bubble/.

Levinson, Arik. 2016. "Energy Efficiency Standards are More Regressive Than Energy Taxes: Theory and Evidence." Working Paper no. 22956. NBER Working Paper Series. R Cambridge, MA: National Bureau of Economic Research. https://www.nber.org/papers/w22956.

Li, Yanling, and Roger Babcock. 2014. "Green Roofs Against Pollution and Climate Change. A Review." *Agronomy for Sustainable Development* 34, no. 4:695-705. https://www.researchgate.net/publication/271680895_Green_roofs_against_pollution_and_climate_change_A_review.

Liebreich, Michael. 2019. "Liebreich: Green New Deal - Trumpism with Climate Characteristics?" *BloombergNEF* (blog), February 27, 2019. https://about.bnef.com/blog/liebreich-green-new-deal-trumpism-climate-characteristics/.

Lilliston, Ben. 2018. "Will the Farm Bill Deliver for the Climate?" Institute for Agriculture & Trade Policy (blog). https://www.iatp.org/blog/will-farm-bill-deliver-climate.

Lilliston, Ben. 2019. Email correspondence. January 24, 2019.

Litman, Todd, and Steven Fitzroy. 2019. "Safe Travels: Evaluating Mobility Management Traffic Safety Impacts." VTPI. https://www.vtpi.org/safetrav.pdf.

Low-Income Home Energy Assistance Program (LIHEAP). 2019. "$3.65 Billion Released to LIHEAP Grantees for Federal Fiscal Year 2019." Butte, Montana: LIHEAP. https://liheapch.acf.hhs.gov/news/oct18/FY.htm.

Lynn, Kathy, Katharine MacKendrick, and Ellen M. Donoghue. 2011. "Social Vulnerability and Climate Change: Synthesis of Literature." Portland: U.S. Department of Agriculture. https://www.fs.fed.us/pnw/pubs/pnw_gtr838.pdf.

MacDonald, Alexander E., Christopher T. M. Clack, Anneliese Alexander, Adam Dunbar, James Wilczak, and Yuanfu Xie. 2016. "Future Cost-Competitive Electricity Systems and their Impact on US CO2 Emissions." *Nature Climate Change* 6, no. 5: 526-31. https://www.nature.com/articles/nclimate2921.

Margolis, Jason. 2015. "8 Million People. No Subway. Can This City Thrive Without One?" *Public Radio International*, October 21, 2015. https://www.pri.org/stories/2015-10-21/can-modern-megacity-bogot-get-without-subway.

Mason, J.W. 2015. "Disgorge the Cash: The Disconnect Between Corporate Borrowing and Investment." New York: Roosevelt Institute. http://rooseveltinstitute.org/disgorge-cash-disconnect-between-corporate-borrowing-and-investment-1/.

Mason, J.W. 2017a. "The Economy During Wartime," review of *Destructive Creation: American Business and the Winning of World War II*, by Mark R. Wilson, Dissent (Fall): 139-43. http://jwmason.org/wp-content/uploads/2015/05/Mason-2017-Destructive-Creation-review.pdf.

Mason, J.W. 2017b. "What Recovery? The Case for Continued Expansionary Policy at the Fed." New York: Roosevelt Institute. http://rooseveltinstitute.org/wp-content/uploads/2017/07/Monetary-Policy-Report.pdf.

Mason, J.W. 2019. "Fiscal Rules for the 21st Century: How to Pay for the Public Sector." New York: Roosevelt Institute. http://rooseveltinstitute.org/wp-content/uploads/2019/03/RI_How-to-pay-for-the-public-sector_issue-brief_201904.pdf.

Mass Save. 2016. "Massachusetts Energy Efficiency Efforts Providing Unprecedented Savings to Customers." Boston: Mass Save. https://www.masssave.com/en/about/news-and-events/News/massachusetts-energy-efficiency-efforts-providing-unprecedented-savings/.

Mazzucato, Mariana. 2013. *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. New York: Anthem Press.

McDonald, Alan, and Leo Schrattenholzer. 2001. "Learning Rates for Energy Technologies." *Energy Policy* 29, no. 4 (March): 255-61. https://www.sciencedirect.com/science/article/pii/S0301421500001221.

McGinn S.M., H.H. Janzen, T.W. Coates, K.A. Beauchemin, and T.K. Flesch. 2016. "Ammonia Emission from a Beef Cattle Feedlot and Its Local Dry Deposition and Re-Emission." *Journal of Environmental Quality* 45, no. 4: 1178-85. https://www.ncbi.nlm.nih.gov/pubmed/27380065.

McGuckin, N., and A. Fucci. 2017. "Summary of Travel Trends: 2017 National Household Travel Survey." Washington, DC: US Department of Transportation . https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf.

McKerracher, Colin. 2018. "Electric Vehicle Outlook: 2018." *BloombergNEF*. https://bnef.turtl.co/story/evo2018?teaser=true.

McKinsey Center for Business and Environment and C40 Cities Climate Leadership Group. 2017. "Focused Acceleration: A Strategic Approach to Climate Action in Cities to 2030." November 2017. https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/a%20strategic%20approach%20to%20climate%20action%20in%20cities%20focused%20acceleration/focused-acceleration.ashx.

Metcalf, Gilbert E., and David Weisbach. 2009. "The Design of a Carbon Tax." *Harvard Environmental Law Review* 33: 499-556. https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=3033&context=journal_articles.

Mikkelson, Gregory M., Andrew Gonzalez, and Garry D. Peterson. 2007. "Economic Inequality Predicts Biodiversity Loss." *PLOS One* 2, no. 5:e444. https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0000444&type=printable.

Mills, Andrew, and Ryan Wiser. 2010. "Implications of Wide-Area Geographic Diversity for Short-Term Variability of Solar Power." Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory. https://www.drecp.org/meetings/2012-07-13_workshop/background/Implications_of_Wide-Area_Geographic_Diversity.pdf.

Monasterolo, Irene, and Marco Raberto. 2019. "The Impact of Phasing Out Fossil Fuel Subsidies on the Low-Carbon Transition." *Energy Policy* 124 (January): 355-70. https://www.sciencedirect.com/science/article/pii/S0301421518305809.

Moser, Susanne C. 2015. "Climate Change Adaptation Policies," in *Encyclopedia of Public Administration and Public Policy*, 3rd ed., ed. Domonic A. Bearfield, Evan M Berman, and Melvin J. Dubnick. New York: Routledge. http://susannemoser.com/documents/AdaptationPolicy_prepub_acceptedforpublication.pdf.

Murphy, Caitlin, Carla Frisch, Elke Hodson, and Aaron Bergman. 2017. "Energy CO2 Emissions Impacts of Clean Energy Technology Innovation and Policy." Washington, DC: US Department of Energy Office of Energy Policy and Systems Analysis. https://www.energy.gov/sites/prod/files/2017/01/f34/Energy%20CO2%20Emissions%20Impacts%20of%20Clean%20Energy%20Technology%20Innovation%20and%20Policy.pdf.

Naam, Ramez. 2019. "How to Decarbonize America–and the World." *TechCrunch*, February 15, 2019. https://techcrunch.com/2019/02/15/how-to-decarbonize-america-and-the-world/.

National Center for Education Statistics (NCES). 2018. "Elementary and Secondary Education." Chap. 2 in *Digest of Education Statistics*: *2016*. Washington, DC: NCES. https://nces.ed.gov/programs/digest/d16/ch_2.asp.

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI). 2019. "U.S. Billion-Dollar Weather and Climate Disasters." Asheville, NC: NCEI. https://www.ncdc.noaa.gov/billions/.

US National Renewable Energy Laboratory (NREL). 2018. "Interconnections Seams Study." Accessed May 30, 2019. https://www.nrel.gov/analysis/seams.html.

Nordhaus, William D. 2017. "Revisiting the Social Cost of Carbon." *Proceedings of the National Academy of Science* 114 no. 7, 1518-23. https://www.pnas.org/content/114/7/1518.

Norwegian Transport Agencies. 2016. "National Transport Plan 2018-2029." https://www.ntp.dep.no/English/_attachment/1525049/binary/1132766?_ts=1571e02a3c.

Organisation for Economic Co-operation and Development (OECD). 2015. "United States Self-Review of Fossil Fuel Subsidies." OECD. https://www.oecd.org/site/tadffss/publication/United%20States%20Self%20review%20USA%20FFSR%20Self-Report%202015%20FINAL.pdf.

Parker, Kim, Juliana Menasce Horowitz, Anna Brown, Richard Fry, D'Vera Cohn, and Ruth Igielnik. 2018. "What Unites and Divides Urban, Suburban and Rural Communities." Washington, DC: Pew Research Center. http://www.pewsocialtrends.org/2018/05/22/demographic-and-economic-trends-in-urban-suburban-and-rural-communities/.

Paul, Mark, William Darity, Jr., and Darrick Hamilton. 2018. "The Federal Job Guarantee–A Policy to Achieve Permanent Full Employment." Washington, DC: Center on Budget and Policy Priorities. https://www.cbpp.org/research/full-employment/the-federal-job-guarantee-a-policy-to-achieve-permanent-full-employment.

Petersen, Alisa, Michael Gartman, and Jacob Corvidae. 2019. "The Economics of Zero-Energy Homes: Single-Family Insights." Boulder, CO: Rocky Mountain Institute. www.rmi.org/economics-of-zero-energy-homes.

Political Economy Research Institute (PERI). 2018. "Toxic 100 Air Polluters Index (2018 Report, Based on 2015 Data)." Accessed May 30, 2019. https://www.peri.umass.edu/toxic-100-air-polluters-index-2018-report-based-on-2015-data.

Pollin, Robert. 2015. *Greening the Global Economy*. Cambridge, MA: MIT Press.

Pollin, Robert, and Brian Callaci. 2019. "The Economics of Just Transition: A Framework for Supporting Fossil Fuel–Dependent Workers and Communities in the United States." *Labor Studies Journal* 44, no. 2: 93-138. https://journals.sagepub.com/doi/10.1177/0160449X18787051.

Pollin, Robert, Heidi Garrett-Peltier, James Heintz, and Bracken Hendricks. 2014. "Green Growth: A U.S. Program for Controlling Climate Change and Expanding Job Opportunities." Washington, DC: Center for American Progress. https://www.americanprogress.org/issues/green/reports/2014/09/18/96404/green-growth/.

Recognizing the Duty of the Federal Government to Create a Green New Deal, H.R. Res. 109, 116th Cong. (2019). https://www.congress.gov/bill/116th-congress/house-resolution/109/text

Redman, Janet. 2017. "Dirty Energy Dominance: Dependent on Denial. How the U.S. Fossil Fuel Industry Depends on Subsidies and Climate Denial." Washington, DC: Oil Change International. http://priceofoil.org/content/uploads/2017/10/OCI_US-Fossil-Fuel-Subs-2015-16_Final_Oct2017.pdf.

Reicher, Dan. 2017. "$41 Billion in Guaranteed Infrastructure? DOE's Loan Guarantee Program is Ready." The Brookings Institution. *The Avenue* (blog), March 2, 2017. https://www.brookings.edu/blog/the-avenue/2017/03/02/doe-loan-guarantee-program-is-ready/.

Risky Business. 2016. "From Risk to Return: Investing in a Clean Energy Economy." Risky Business. https://riskybusiness.org/site/assets/uploads/sites/5/2016/10/RBP-FromRiskToReturn-WEB.pdf.

Ritchie, Hannah. 2017. "How Long Before We Run Out of Fossil Fuels?" *Our World in Data*, August 8, 2017. https://ourworldindata.org/how-long-before-we-run-out-of-fossil-fuels#note-8.

Roberts, David. 2018. "We've Been Talking About a National Grid for Years. It Might Be Time to Do It." *Vox*, August 3, 2018. https://www.vox.com/energy-and-environment/2018/8/3/17638246/national-energy-grid-renewables-transmission.

Roberts, David. 2019. "The Green New Deal Aims to Get Buildings Off Fossil Fuels. These 6 Places Have Already Started." *Vox*, March 30, 2019. https://www.vox.com/energy-and-environment/2019/3/20/18269356/green-new-deal-building-electrification-states-cities.

Robert, David, and Alvin Chang. 2018. "Meet the Microgrid, the Technology Poised to Transform Electricity." *Vox*, May 24, 2018. https://www.vox.com/energy-and-environment/2017/12/15/16714146/greener-more-reliable-more-resilient-grid-microgrids.

Rogoff, Kenneth. 2019. "Never Mind the Debt: If There's a Hard Brexit Britain Will Have to Splash the Cash." *Sunday Times*, February 3, 2019. https://scholar.harvard.edu/files/rogoff/files/the_sunday_times_february_3_2019_rogoff.pdf.

Pedroso, Margo. 2017. "Investing in Walking, Biking, and Safe Routes to School." Fort Washington, MD: Safe Routes to School National Partnership. https://www.saferoutespartnership.org/sites/default/files/resource_files/121117-sr2s-investing_report-final.pdf.

Santos, Adella, Nancy McGuckin, Hikari Yukiko Nakamoto, Danielle Gray, and Susan Liss. 2011. "Summary of Travel Trends: 2009 National Household Travel Survey." Washington, DC: US Department of Transportation. https://nhts.ornl.gov/2009/pub/stt.pdf.

Schwartz, John. 2018. "Young People Are Suing the Trump Administration Over Climate Change. She's Their Lawyer." *New York Times*, October 23, 2018. https://www.nytimes.com/2018/10/23/climate/kids-climate-lawsuit-lawyer.html.

Shindell, Drew T., Yunha Lee, and Greg Faluvegi. 2016. "Climate and Health Impacts of US Emissions Reductions Consistent with 2oC." *Nature Climate Change* 6, no. 5 (May): 503-7. https://media.nature.com/original/nature-assets/nclimate/journal/v6/n5/extref/nclimate2935-s1.pdf.

Skocpol, Theda. 2013. "What It Will Take to Counter Extremism and Engage Americans in the Fight Against Global Warming." Harvard University (report prepared for symposium on "The Politics of America's Fight Against Global Warming," co-sponsored by Columbia School of Journalism and Scholars Strategy Network, Cambridge, MA, February 14, 2013. https://grist.files.wordpress.com/2013/03/skocpol-captrade-report-january-2013y.pdf.

Smith, Noah. 2018. "How to Design a Green New Deal That Isn't Over the Top." *Bloomberg*, February 12, 2019, sec. Opinion. https://www.bloomberg.com/opinion/articles/2019-02-12/an-alternative-to-alexandria-ocasio-cortez-s-green-new-deal?utm_medium=social&cmpid=socialflow-twitter-business&utm_campaign=socialflow-organic&utm_source=twitter&utm_content=business.

Smith, Rich. 2019. "King County Passes Temporary Ban on Fossil Fuel Infrastructure." *Stranger*, January 29, 2019. https://www.thestranger.com/slog/2019/01/29/38394068/king-county-passes-temporary-ban-on-fossil-fuel-infrastructure.

Solar Energy Industries Association (SEIA). 2017. "Solar Installer: The Fastest-Growing Job in America." *SEIA* (blog), October 26, 2017. https://www.seia.org/blog/solar-installer-fastest-growing-job-america.

Stacy, Christina, Brady Meixell, and Serena Lei. 2019. "Too Far from Jobs: Spatial Mismatch and Hourly Workers." Washington, DC: Urban Institute. https://www.urban.org/features/too-far-jobs-spatial-mismatch-and-hourly-workers.

Stern, Nicholas. 2007. *Stern Review: The Economics of Climate Change*. Cambridge, UK: Cambridge University Press.

Stevens, Harry. 2018. "Corporate America Leans GOP in 2018 Midterms." *Axios,* November 1, 2018. https://www.axios.com/corporate-america-campaign-contributions-midterms-ca695de3-7700-414c-af2c-9599dbce2713.html.

Stiglitz, Joseph E. 2013. "A Revolution in Monetary Policy: Lessons in the Wake of the Global Financial Crisis." Presented at the 15th CD Deshmukh Memorial hosted by the Reserve Bank of India, Mumbai, India, January 3, 2013.

Summers, Lawrence H. 2014. "US Economic Prospects: Secular Stagnation, Hysteresis, and the Zero Lower Bound." *Business Economics* 49, no. 2 (February): 65-73. http://larrysummers.com/wp-content/uploads/2014/06/NABE-speech-Lawrence-H.-Summers1.pdf.

https://www.economist.com/graphic-detail/2017/01/16/china-powers-ahead-with-a-new-direct-current-infrastructure.

Torras, Mariano, and James K. Boyce. 1998. " Income, Inequality, and Pollution: A Reassessment of the Environmental Kuznets Curve." *Ecological Economics* 25, no. 2 (May): 147-60. https://www.sciencedirect.com/science/article/pii/S0921800997001778.

Trabish, Herman K. 2018. "Can the Price of Rooftop Solar Keep Falling?" *Utility Dive*, October 18. 2018. https://www.utilitydive.com/news/can-the-price-of-rooftop-solar-keep-falling/539612/.

Trout, Kelly, and Lorne Stockman. 2019. "Drilling Towards Disaster: Why U.S. Oil and Gas Expansion is Incompatible with Climate Limits." Washington, DC: Oil Change International. http://priceofoil.org/content/uploads/2019/01/Drilling-Towards-Disaster-Web-v3.pdf.

University of Groningen and University of California, Davis. 2016. "Share of Labour Compensation in GDP at Current National Prices for United States." FRED, Federal Reserve Bank of St. Louis. Last updated June 29, 2016. https://fred.stlouisfed.org/series/LABSHPUSA156NRUG.

Walawalkar, Rahul, Jay Apt, and Rick Mancini. 2007. "Economics of Electric Energy Storage for Energy Arbitrage and Regulation in New York." *Energy Policy* 35, no. 4 (April): 2558-68. https://www.sciencedirect.com/science/article/pii/S0301421506003545.

Walsh, Jim. 2018. "Carbon Pricing: 5 Reasons It Won't Work." Food & Water Watch. https://www.foodandwaterwatch.org/news/carbon-pricing-5-reasons-it-wont-work.

Wiser, Ryan, Trieu Mai, Dev Millstein, Galen Barbose, Lori Bird, Jenny Heeter, David Keyser, Venkat Krishnan, and Jordan Macknick. 2017. "Assessing the Costs and Benefits of US Renewable Portfolio Standards." *Environmental Research Letters* 12, no. 9 (September): 94023. https://iopscience.iop.org/article/10.1088/1748-9326/aa87bd/meta.

World Bank. 2019. "Research and Development Expenditure (% of GDP)." Accessed May 30, 2019. https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.zs?year-high-desc=true.

World Health Organization (WHO). 2014. "Quantitative Risk Assessment of the Effects of Climate Change on Selected Causes of Death, 2030s and 2050s." Geneva: WHO. http://www.who.int/iris/handle/10665/134014.

Wright, Gavin, and William Robertson Coe. 2006. "Productivity Growth and the American Labor Market: The 1990s in Historical Perspective," in *The Global Economy in the 1990s: A Long-Run Perspective*, ed. Paul W. Rhode and Gianni Toniolo, 139-60. Cambridge, UK: Cambridge University Press.

Zomer, Robert J., Deborah A. Bossio, Rolf Sommer, and Louis V. Verchot. 2017. "Global Sequestration Potential of Increased Organic Carbon in Cropland Soils." *Scientific Reports* 7, no. 1: 15554. https://www.nature.com/articles/s41598-017-15794-8.

350.org. n.d. "350 Campaign Update: Divestment." Accessed May 30, 2019. https://350.org/350-campaign-update-divestment/.

ROOSEVELTINSTITUTE.ORG