

A Citizen's Guide to Climate Change

The Causes, Impacts, and
Potential Solutions

*Written by West Virginians for West Virginians
and for those who treasure our state.*

West Virginia Climate Alliance

September 2020

Table of Contents

Introduction.....	1
The Causes of Climate Change	2
The Impacts of Climate Change	3
Impacts in West Virginia	3
Global Impacts.....	4
Potential Solutions for Addressing Climate Change.....	6
Protecting Vulnerable Populations.....	6
Environmental justice.....	6
Just transition.....	6
Green New Deal.....	6
Regulatory Approach.....	7
Putting a price on carbon: carbon fee and dividend	7
Putting a price on carbon: cap-and-trade.....	9
Other Potential Strategies	10
Maintaining and strengthening international agreements.....	10
Corporate Average Fuel Economy (CAFE) standards	10
Tax incentives for low- and no-carbon technologies.....	11
Incentives for agriculture and forestry	11
Removing carbon dioxide from the air	11
Conclusion.....	12
West Virginia Resources.....	13
Endnotes.....	13

Acknowledgements

The West Virginia Climate Alliance is a newly formed alliance comprised of environmental, faith based, and civic organizations whose mission is to provide public education on climate change. This publication is made possible by financial contributions from West Virginia Center on Budget and Policy, West Virginia Citizen Action Education Fund, and West Virginia Rivers Coalition.

The Guide has the support of a number of West Virginia organizations, including: American Friends Service Committee, Christians for the Mountains, Center for Energy and Sustainable Development, Citizens' Climate Lobby West Virginia, League of Women Voters of West Virginia, Mid-Ohio Valley Climate Action, Moms Clean Air Force-West Virginia, Ohio Valley Environmental Coalition, Sierra Club of West Virginia, West Virginia Center on Budget and Policy, West Virginia-Citizen Action Education Fund, West Virginia Interfaith Power and Light, and West Virginia Rivers Coalition.

The Guide was designed by Colleen Anderson of Mother Wit Writing and Design (motherwitdesign.com).

We hope you find this publication helpful. If you have questions or concerns, please don't hesitate to contact Perry Bryant at perrybryantwv@outlook.com.

Cover image: Lindy Point, Tucker County, West Virginia. Photo © Kent Mason - WVphotographs.com.



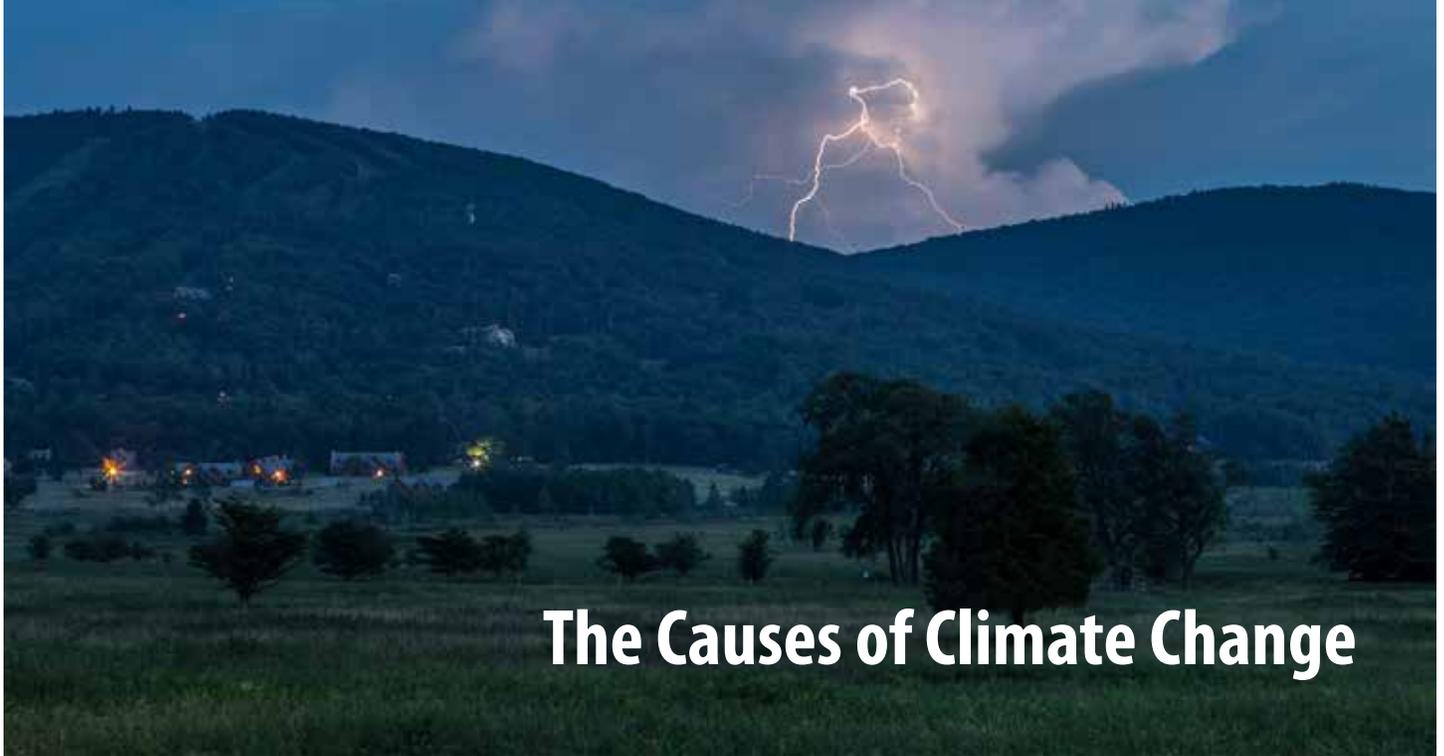
Introduction

Trail through spruce forest, Blackwater Falls State Park, WV.
Photo © Kent Mason - WVphotographs.com

Climate change is one of the most challenging issues of our time. By addressing climate change we have an opportunity to build a stronger, cleaner, and more just economy. But it's not just economics that justify taking action. We have a moral obligation to address climate change sooner rather than later for the sake of our children, their children, and generations still to come.

This guide is intended for people who are concerned about climate change and want more information. Its purpose is to provide factual, objective information on the science of why climate change is occurring; identify key impacts of climate change in West Virginia and across the globe; and outline some potential solutions.

The Guide relies heavily on scientific research from government agencies: the Environmental Protection Agency (EPA), the National Climate Assessment, the National Oceanic and Atmospheric Administration (NOAA), the UN Intergovernmental Panel on Climate Change as well as academic research on climate change. Our objective is to provide scientifically valid information on a subject that has been overly politicized.



The Causes of Climate Change

Storm over Dolly Sods, West Virginia. Photo by Al Peery - PeeryPhoto.com

Greenhouse gases are the main drivers of climate change. Most greenhouse gases in the atmosphere are natural. Without water vapor, naturally occurring carbon dioxide (CO₂), and other greenhouse gases, Earth would have an average temperature of 0° Fahrenheit (F) instead of the 59°F that we currently enjoy.¹

The energy we receive from the sun in the form of sunshine is partially reflected back into space by clouds, snow, and ice. The rest of the energy is absorbed by lands and oceans. Later this energy is radiated back into space in the form of invisible infrared energy. Greenhouse gases absorb this outgoing infrared energy and get warmer, and then re-radiate this energy both upward into space and downward toward the surface.

The more greenhouse gases in the atmosphere, the more energy that is re-radiated to the surface, and the warmer our climate becomes. Today, carbon dioxide levels in the atmosphere are greater than at any time in the last 800,000 years.²

Not all greenhouse gases are the same. Methane, the main component of natural gas, is a potent greenhouse gas. Over a century, methane traps between 28 and 36 times more heat in the atmosphere than carbon dioxide does, according to the U.S. Environmental Protection Agency (EPA).³ But methane breaks down over a relatively short time frame – about ten years.⁴

That stands in stark contrast to carbon dioxide, which is a less potent greenhouse gas than methane at

trapping heat in the atmosphere, but is more prevalent and much longer lasting. “CO₂ emissions cause increases in atmospheric concentration of CO₂ that will last thousands of years,” according to the EPA.⁵ That means that some of the emissions of carbon dioxide from the beginning of the Industrial Revolution in the 1850s are having an impact on our climate today. And it means that even if we stop burning all fossil fuels today, some of the carbon dioxide emissions already in the atmosphere will continue to affect the climate in 2100 and well beyond.

Two other facts about carbon dioxide are important. First, half of all the carbon dioxide put into the atmosphere since the beginning of the Industrial Revolution has been emitted in the last three decades.⁶ Second, we already have too much carbon dioxide in the atmosphere. We reached a level of 416 parts per million (ppm) of carbon dioxide in the atmosphere in April 2020.⁷ Scientists believe that if we want to avoid the worst impacts of climate change, we need to reduce that level to 350 ppm.⁸

Because of the long-lasting impact of CO₂ and its concentrations in the atmosphere, simply reducing future carbon dioxide emissions is not enough. We will need to take carbon dioxide out of the air through natural means such as planting trees and through technology (see page 11).



The Impacts of Climate Change

Elkview, West Virginia, June 25, 2016. Photo by David Stephenson - davidtstephenson.com

When it comes to understanding the impacts of climate change on the environment and human health, Dr. David Titley put it in perspective. Dr. Titley, a former Affiliate Professor of meteorology at Pennsylvania State University, said that climate change is the opposite of an old company slogan that claimed: “We don’t make things, we make things better.” Climate change doesn’t make things, it makes things worse.⁹ With that in mind, here are some projected and already occurring impacts of climate change.

Impacts in West Virginia

Flooding: Warmer air can hold more water vapor than cooler air. Additionally, warmer conditions increase evaporation of water from forests, agricultural fields, streams, rivers, and lakes, returning more water to the atmosphere. This is called “water cycle intensification” and is partially responsible for the increase of extreme rain events throughout the U.S.¹⁰ and in the Northeast in particular.¹¹

West Virginia has already experienced a 1,000-year rain event in June 2016, with devastating effects

in Clendenin, White Sulphur Springs, and Richwood. These floods killed 23 people and may have been made worse by climate change according to the National Oceanic and Atmospheric Administration (NOAA).¹² According to the Third National Climate Assessment, the number of heavy precipitation events in West Virginia could double or even increase fivefold by the end of the century depending on whether we dramatically reduce greenhouse gas emissions or continue emitting greenhouse gases unabated.¹³

Heat waves: In September and October 2019, West Virginia suffered through some of the hottest temperatures ever recorded during this time of year. Huntington, Beckley, and Clarksburg recorded their hottest September ever, and Charleston nearly broke its record.¹⁴ According to a U.S. Forest Service report, temperatures in Central Appalachia, which includes all of West Virginia, are projected to increase by 7.8 °F by the end of the century if we fail to reduce greenhouse gas emissions.¹⁵ To put this in perspective, the difference between Montreal being buried under two miles of ice and snow during the last ice age and its present-day balmy weather is an increase in climate temperature of

11°F.¹⁶ Relatively small differences in climate temperature can make a huge difference in livability.

Invasive species, species at-risk, and pests: With the warmer temperatures from climate change, invasive species like kudzu will expand their reach even further north.¹⁷ Species at-risk from warming temperatures in West Virginia include red spruce, the northern flying squirrel, Cheat Mountain salamanders, and eastern brook trout.¹⁸ Ticks which can transmit Lyme disease and rocky mountain spotted fever could proliferate in the warmer temperatures. And hemlock wooly adelgid and emerald ash borer, which have already decimated our hemlock and ash trees, may find the climate even more to their liking with fewer cold snaps to keep them in check.¹⁹

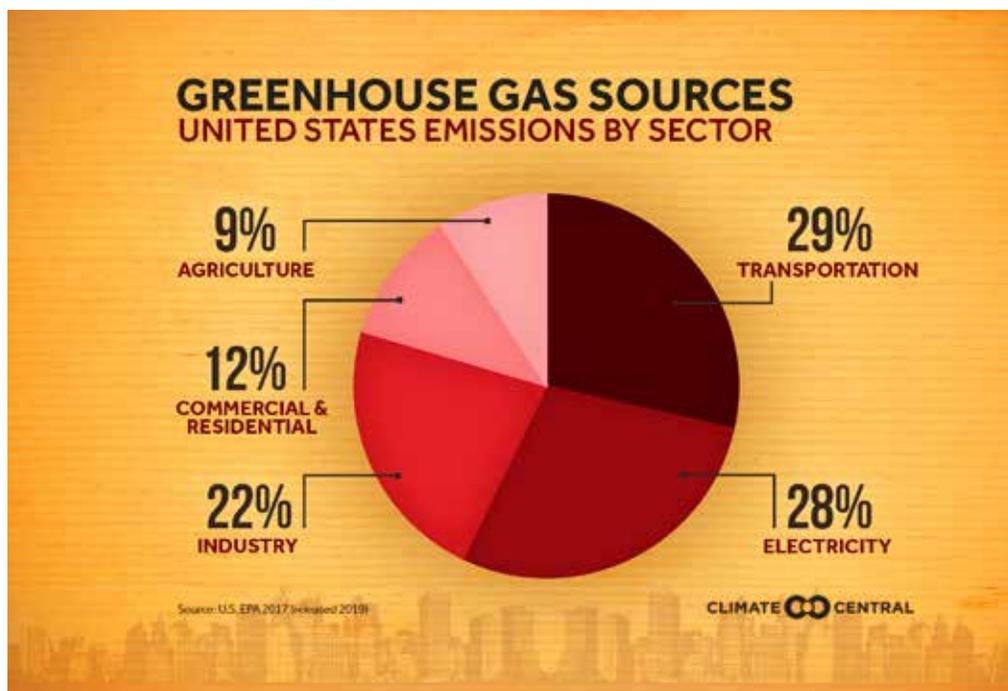
Global Impacts

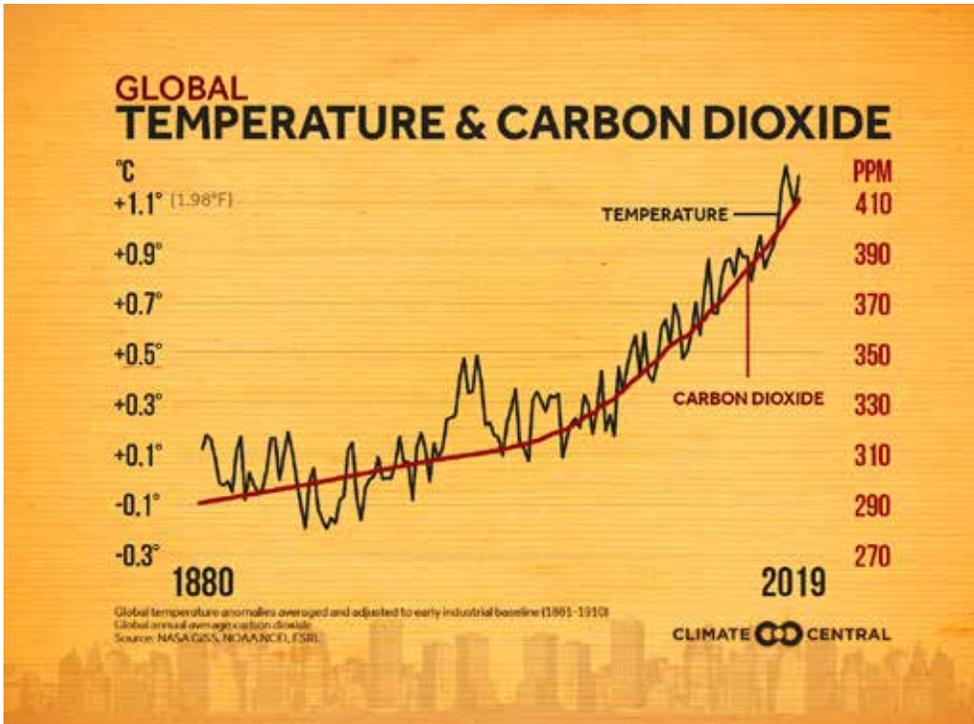
Wildfires: Increasing temperatures will lead to drier conditions which can cause more frequent and more intense wildfires. Since the 1970s, the fire season in California has grown by two and a half months.²⁰ The

Camp Fire, the worst in California history, killed 85 people and burned almost 240 square miles -- about two-thirds of the size of Monongalia County. But it's not just the American West that is witnessing more frequent and more intense wildfires. The same is happening in the Amazon, Australia, and Siberia. When forests are burned by intense wildfires, they are no longer serving as a carbon sink -- removing carbon dioxide from the air -- but instead they become a source of carbon dioxide emissions.

Melting ice and snow and sea level rise: Warmer water takes up more space than cooler water. The rise in sea levels is the result of the oceans being warmer and the melting of glaciers and the ice sheets in Greenland and Antarctica, which are melting at alarming rates. The Greenland Ice Sheet, for example, lost 247 billion tons of ice in 2016, up from 34 billion tons in 2001. Similarly, Antarctica lost 51 billion tons of ice in 2001 and that loss quadrupled by 2016 to 199 billion tons, according to NOAA.²¹

Right: Source U.S. EPA 2017 (released 2019)





Left: Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910) Source NASA GISS, NOAA NCEI, ESRL

depression, violence, including child and domestic abuse.²⁵ Chronic mental health and child development problems may also result from persistent or traumatic climate events.

Other Impacts: There are numerous other impacts of climate change. Climate change threatens drinking water and food production in large parts of the globe, which could trigger mass migration. The ferocity of hurricanes like Harvey, Maria, Irma, and Sandy was fueled by waters warmed

by climate change in the Atlantic Ocean and the Gulf of Mexico. These hurricanes have had devastating impacts, including loss of lives, homes, and communities.

Additionally, carbon dioxide that is absorbed by the oceans forms a weak acid, which is acidifying the oceans²⁶ and contributing to the decline of coral reefs and fisheries. Even with a climate temperature increase of just 2°C (3.6°F) above the climate temperatures at the beginning of the Industrial Revolution 99 percent of the coral reefs around the globe will decline, according to the Intergovernmental Panel on Climate Change (IPCC).²⁷

Drought is also a major impact of climate change in the United States and globally. Drought can lead to arable land turning into deserts.

This is not an exhaustive list of the impacts of climate change. But hopefully it gives you enough understanding of some of the impacts of climate change and why we need to act now to avoid even worse consequences.

The Fourth National Climate Assessment found that sea levels are “very likely” to rise between one and four feet by the end of the century.²² NOAA found that with a high emissions scenario, which they considered extremely unlikely but which “cannot be ruled out,” that sea levels rise could be as much as 8.2 feet.²³ Even the four-foot rise in sea levels could have an adverse effect on the 40 percent of the US population that live in coastal areas, as well as eight of the world’s 10 largest cities that are located near or on coastlines. An 8.2-foot rise in sea levels could have devastating effects across the globe.

Sea level rise has already resulted in flooding during high tide, even on sunny days. There are now over 49 locations in the US with accelerating high tide flooding trends, and 19 locations with trends that are linearly increasing.²⁴ Additionally, sea level rise has made storm surges from hurricanes higher and more deadly.

Impact on mental health: Climate-intensified disasters such as hurricanes, wildfires, flooding, and heat stress can cause acute traumatic stress, resulting in anxiety,



Potential Solutions for Addressing Climate Change

Father and son fishing on the Potomac River, Smoke Hole Canyon, WV. Photo © Kent Mason - WVphotographs.com

This section describes four different basic approaches to addressing climate change: a Green New Deal, regulatory approach, putting a price on carbon dioxide emissions either through a carbon fee and dividend or through a cap-and-trade initiative. These approaches are not mutually exclusive. For example, future legislation could impose a tax on carbon dioxide to restructure the generation of electricity and also adopt fuel-efficiency regulations to reform our transportation system.

We leave it to your judgement to determine which solutions best suit your personal philosophy. We believe, however, that two provisions should be included in any climate change solution: environmental justice and a just transition.

Protecting Vulnerable Populations

Environmental justice ensures that the needs of those who are the least likely to have contributed to climate change and the most likely to bear the burden of fixing climate change (i.e., low-income communities,

communities of color, and citizens of developing nations) are protected from further injustice. Whether it's the citizens in Bangladesh, the Lower 9th Ward in New Orleans or Institute, West Virginia, we need to ensure that their needs are adequately addressed, that they have a voice in how climate change is addressed, and that they do not pay a disproportionate cost for addressing climate change.

A **just transition** recognizes that fossil-fuel workers and their communities, and in particular coal miners and their communities, will be disproportionately impacted as we move to a low-carbon economy. A just transition would ensure that their pensions and health insurance plans are protected, and that they are provided quality job retraining and other assistance, (e.g., reduced wages), so that they are not left behind in this transition.

A Green New Deal

A Green New Deal has been referred to as THRIVE for Transform, Heal, Renew by Investing in a Vibrant Economy by a number of national organizations. The

Green New Deal or THRIVE charts a transition away from a fossil-fuel-driven economy to a sustainable economy. Ten million jobs are projected to be created over ten years, and a just transition for fossil fuel workers is included in the creation of these jobs, as is environmental justice.²⁸

The Green New Deal has numerous components, including but not limited to the following:

- Transitioning to a low-carbon economy by requiring 100 percent renewable electricity by 2035; having zero-net emissions from energy by 2050; net-zero building energy standards by 2030; zero-emission passenger vehicles by 2030, and fossil-free transportation by 2050. (Note: net-zero emissions means that we will still be emitting carbon dioxide into the atmosphere in 2030 or even 2050, but that we will be removing as much carbon dioxide from the atmosphere as we are emitting.)
- Establishing a right to clean air and water by, among other things, cutting methane leakage emissions by 50 percent by 2025 and establishing a national lead water pipe replacement initiative.
- Planting trees on 40 million acres by 2035, restoring 5 million acres of wetlands by 2040, and applying sustainable farming practices to 70 percent of agricultural lands by 2050.

Wind turbines on top of Mount Storm, WV. Photo © Kent Mason - WVphotographs.com



Regulatory Approach

Under the traditional regulatory approach, Congress could explicitly require EPA to regulate carbon dioxide emissions from power plants and regulate other greenhouse gases such as methane. Each polluter would be required to make investments in emissions-reduction technology to achieve air pollution standards, without the ability to reduce costs by trading allowances with other emitters. Given the lengthy administrative process associated with adopting these regulations, this approach would likely take years to implement. We may not have sufficient time to develop regulations before it is necessary to achieve meaningful reductions in greenhouse gas emissions.

Putting a Price on Carbon: Carbon Fee and Dividend

Placing a price on carbon has drawn the support of many economists, including Alan Greenspan, Ben Bernanke, and Janet Yellen (all former Chairs of the Federal Reserve). There have been at least two proposals to put a price on carbon through a carbon tax: the Citizens' Climate Lobby proposal and the Climate Leadership Council proposal.

Citizens' Climate Lobby, a grassroots organization, supports a bipartisan carbon fee and dividend initiative.



Elakala Falls, Blackwater State Park, Davis, WV. Photo © Kent Mason - WVphotographs.com

This initiative would place a fee of \$15-per-metric-ton on carbon dioxide (and an equivalent fee on other greenhouse gases), rising by \$10 per year reaching \$115 a ton by 2030. The fee would be assessed at the mine site or at the natural gas or oil well head, and passed along to consumers in the form of higher energy prices. The increased cost to consumers would be based on the amount of energy they use and how much carbon is in that energy. The revenues generated by this fee would be distributed back to American households on a per capita basis as a monthly dividend check.²⁹

Citizens' Climate Lobby commissioned a study by the Regional Economic Model, Inc. (REMI) that found

that low-income Americans would actually benefit from a carbon fee and dividend initiative, since low-income Americans use less energy than higher-income Americans.³⁰ However, environmental justice advocates worry that without energy efficiency initiatives targeted to low-income Americans, increasing energy costs on substandard housing could have an adverse effect on low-income Americans even with the rebates.³¹

Citizens' Climate Lobby projects that in 20 years a carbon fee and dividend initiative would reduce carbon emissions by 50% below 1990 levels, create 2.1 million additional jobs, and avoid 230,000 premature deaths over 20 years from reducing pollutants that often accompany carbon dioxide emissions.³²

The Climate Leadership Council, an organization led by former Secretaries of State George Schultz and Jim Baker and others, has a similar proposal to put a price on carbon. Its carbon fee starts at \$40 a ton on carbon dioxide emissions (and an equivalent fee on other greenhouse gases), and increases every year at 5 percent above inflation, reaching a high of \$65 per ton by 2030. The carbon fee would be paid by polluters and passed onto energy consumers in the form of higher energy costs. However, all proceeds from this fee would be rebated to the American people on a per capita basis in order to reduce the impact on energy consumers.

The Climate Leadership Council projects that its proposal would reduce carbon dioxide emissions by 50% by 2035.³³

The Citizens' Climate Lobby proposal would delay EPA's authority to regulate carbon dioxide emissions for a decade, while the Climate Leadership Council proposal would eliminate EPA's authority to regulate carbon dioxide emissions altogether. Additionally, the Climate Leadership Council's proposal would provide the fossil fuel industry with immunity from legal action for its past emissions of greenhouse gases.

Neither proposal has a just transition component to assist fossil fuel workers and their communities to transition to a low-carbon economy. However, the

Citizens' Climate Lobby affiliate in West Virginia has developed a comprehensive just transition plan for fossil fuel workers that includes pension and health care protection, retraining programs, partial income replacement for workers who end up in lower paying jobs, and relocation assistance.

Putting a Price on Carbon: Cap-and-Trade

Under a cap-and-trade initiative, polluters would be required to purchase allowances based on the amount of greenhouse gases they emit. Over time, these allowances would be reduced, forcing industries to reduce their emissions. Polluters that are able to achieve greater reductions would be able to trade or sell their excess allowances to emitters who are emitting more than authorized. Cap-and-trade was used successfully in the early 1990s and 2000s to drive down the emissions of sulfur dioxide, a major cause of acid rain. And it was the structure of a 2009 climate change bill that passed the U.S. House of Representatives but died in the U.S. Senate. Keys to the effectiveness of this approach would be

River otter at West Virginia State Wildlife Center, French Creek. WV. Photo © Kent Mason - WVphotographs.com



Photo © Coalfield Development, Inc. Solar installers from Coalfield Development's Rewire Appalachia, working in Shepherdstown.

setting the limits low enough to at least reach the goals outlined in the Paris Climate Accord, and ensuring that select industries aren't given preferential treatment.

One concern with the cap-and-trade approach is that "hot spots" may result from large polluters maintaining existing emission levels by purchasing allowances rather than taking any action to reduce their emissions. Heavily polluting industries are frequently located in low-income communities and communities of color. These residents could be the last to see reduction in air pollution under a cap-and-trade initiative.³⁴

There is a clear difference between the Green New Deal and regulatory approaches versus the two market-based approaches of placing a price on carbon either through a carbon fee or through cap-and-trade. The Green New Deal and the regulatory approach are much more prescriptive in their efforts to address climate change, by requiring various industries to meet established criteria. Putting a price on carbon through a carbon fee or a cap-and-trade program would provide a financial incentive for industries to reduce their greenhouse-gas emissions, but would leave it to industries on how best to achieve this objective.



Other Potential Solutions

Dawn at the Nature Conservancy Bear Rocks Preserve, WV. Photo © Kent Mason - [WV photographs.com](http://WVphotographs.com)

Maintaining and Strengthening the Paris Climate Accord or Similar International Agreements:

Ultimately, climate change is a global crisis, requiring a global solution. The United States should not only remain in the Paris Climate Accord, but also lead the effort to strengthen the agreement to assure that the promises made by countries to reduce their greenhouse gas emissions are enforced. Only such an overarching, binding agreement will spur nations around the globe to do their part to reduce greenhouse gas emissions without worrying about whether other countries are continuing with business as usual.

Corporate Average Fuel Economy (CAFE) standards:

Transportation now accounts for more greenhouse gas emissions than any other sector, including electricity generation. The Obama Administration established a CAFE standard that would have required new cars and light trucks to achieve an average of 54 miles per gallon by 2025. The Trump Administration repealed the Obama Administration CAFE standard and adopted a new standard that will only require new cars and light trucks to obtain a 40 mile per gallon average by 2025. This revised CAFE standard will result in an increase of almost a billion tons of greenhouse gas emissions over the next

five years.³⁵ One approach to addressing climate change would be to adopt a strong CAFE standard.

Tax incentives for adopting low- and no-carbon technologies: Investments in energy efficiency are the lowest-cost means of reducing greenhouse gas emissions, and also provide consumers with the tool to help control their energy costs. A whole host of technologies could be incentivized through the tax code, including rooftop solar, electric vehicles, energy efficiency programs, smart grid systems, zero emission appliances, etc. Over the next few years, tax credits for wind and solar are both scheduled to be phased out. These and other tax credits for investing in energy efficiency measures could and should be restored, as well as eliminating existing subsidies for the fossil fuel industry as an effective means of moving to a low-carbon economy.

Incentives for agriculture and forestry: Both agriculture and forestry are significant sources of greenhouse gas emissions but could be a significant sink for sequestering greenhouse gases. For example, according to the U.S. Forest Service, forests in Central Appalachia sequester 69 metric tons of carbon dioxide per acre.³⁶ Offering financial incentives to ensure that farms and forest are carbon sinks and not sources of carbon dioxide emissions is one partial but significant solution to climate change.

Removing carbon dioxide from the air: We can naturally remove carbon dioxide from the air by planting trees. Trees (and other vegetation) absorb carbon dioxide during the photosynthesis process, storing the carbon in trees and in the soil. The United Nations has proposed planting a trillion trees across the globe. Once these planted trees mature, they will sequester a projected 205 billion tons of carbon dioxide,³⁷ although some believe this estimate to be unrealistically high. To put this number in perspective, the global carbon dioxide emissions from burning fossil fuel and industrial processes was 37 billion tons in 2018.³⁸

In addition to natural sequestration of carbon, some technologies may be needed to remove carbon dioxide

from the atmosphere. These technologies include capturing carbon dioxide from the flue gases at power plants and then either sequestering the carbon dioxide deep underground (carbon capture and sequestration) or utilizing the carbon (carbon capture and utilization). The most frequent use for captured carbon dioxide is for enhanced oil recovery. There may be other uses for captured carbon dioxide, including building material, carbon fiber, polymers, and fuel.

Carbon capture and sequestration is expensive and consumes enormous amounts of power. Appalachian Power Company tried carbon capture and sequestration at its Mountaineer plant in New Haven, West Virginia. Although the process removed 90 percent of the carbon dioxide, it almost doubled the cost of electricity and took up acres of land.³⁹ Eventually, APCo abandoned the project.

Some see research into carbon capture and sequestration as a waste of money and as the last gasp of the coal industry. Yet the United Nations Intergovernmental Panel on Climate Change (IPCC), has found that developing this technology maybe essential if the earth is going to avoid the worst impacts of climate change.⁴⁰ If developed, this technology could also be used to reduce carbon dioxide from hard-to-decarbonize industries, particularly steel and cement production. And if the United States could make this technology economically feasible, we could export the technology to countries such as China and India that have been slow to move beyond coal-fired utilities.

There is another technology that removes carbon dioxide from the atmosphere called direct air capture. Rather than trying to capture carbon dioxide in the flue gases, direct air capture removes carbon dioxide from the ambient air. It too is currently too expensive to operate, and the technology of storing carbon dioxide deep underground for hundreds or even thousands of years is unproven. Yet it may be a vital technology in addressing climate change since, as noted earlier; there is already too much carbon dioxide in the atmosphere and that carbon dioxide is going to impact the climate for hundreds of years.



Conclusion

South Prong Trail, Dolly Sods Wilderness, WV. Photo © Kent Mason - WVphotographs.com

The IPCC stated that we have until 2030 to reduce emissions of carbon dioxide by 45 percent if we are going to avoid the worst impacts of climate change. Each year that we fail to make progress makes future reforms much more difficult. For those with the resources necessary to reduce their carbon and methane footprint, personal responsibility plays a role. Those of us who can afford it should do our part, such as driving fuel efficient or electric vehicles, insulating our homes, and installing rooftop solar arrays. But personal responsibility is not adequate to address the climate change crisis.

To address climate change on the scale required, systemic changes are needed. Vital components include reducing the demand for fossil fuel products, including petrochemicals, changing how we generate electricity, making the electrical grid much more efficient, electrifying our transportation system, ensuring that agriculture and forestry are carbon sinks, and making homes and industries energy efficient.

Reducing and ultimately eliminating burning of fossil fuels improves our health and our environment. Air pollution from all sources kills more than 100,000 Americans each year, according to a 2019 study in the Proceedings of National Academy of Sciences.⁴¹

Additionally, petroleum refineries disproportionately impact African-Americans, Latinos and low-income communities and have the biggest adverse health impact from air pollution of any major industrial sector in the U.S.

Renewable energy is not only good for our health and our planet, it is now the cheapest form of energy, according to Lazard, an international financial management company. Their research found that the costs for large scale solar projects, called utility-grade solar, fell from \$369 per megawatt hour in 2009 to \$40 per megawatt hour in 2019 – an 89% reduction in ten years. Wind energy is only slightly more expensive at \$41 per megawatt hour. Large scale batteries, the glue that makes renewables reliable, have also substantially dropped in cost. Their capital costs have gone from \$1,200 per kilowatt hour in 2010 to less than \$300 per kilowatt hour in 2019 – a 75 percent reduction. Conversely, in 2019, natural gas cost \$91 per megawatt hour, according to Lazard, while coal cost \$109 per megawatt hour.

Finally, taking meaningful action to address climate change will allow us to keep the sacred commitment that past generations made to us and one that we should make to future generations: that their lives will be better and more fulfilling than ours, and that we will leave them and their children a livable planet.

West Virginia Resources

American Friends Service Committee, Charleston - <https://www.afsc.org/charleston-wv>
Changing Climate Times newsletter/podcast - <https://changingclimatetimes.substack.com/>
Christians for the Mountains - <https://www.christiansforthemountains.org/>
Citizens' Climate Lobby West Virginia - www.facebook.com/CCLWV
League of Women Voters of West Virginia - <https://lwvww.org/>
Mid-Ohio Valley Climate Action - <http://main.movclimateaction.org/>
New Day for the Coalfields - <http://newday4.homestead.com/>
Moms Clean Air Force West Virginia Chapter - <https://www.momscleanairforce.org/state-chapters/west-virginia/>
NAACP - <https://www.facebook.com/charlestonwvnaacp>
Ohio Valley Environmental Coalition - <https://ohvec.org/>
Sierra Club of West Virginia - <https://www.sierraclub.org/west-virginia>
West Virginia Center on Budget and Policy - <https://wvpolicy.org/>
West Virginia Center on Climate Change - <http://wvclimate.org>
West Virginia Citizens Action Group - <https://wvcag.org>
West Virginia Environmental Council - <https://wvecouncil.org>
West Virginia Highlands Conservancy - <https://wvhighlands.org/>
West Virginia Interfaith Power and Light - <https://www.wvipl.org/>
West Virginia Rivers Coalition - <https://wvivers.org>

Endnotes

- 1 Ma, Quiancheng, Science Briefs: Greenhouse Gases: Refining the Role of Carbon Dioxide, NASA Goddard Institute for Space Studies. (March 1998). See https://www.giss.nasa.gov/research/briefs/ma_01/
- 2 Lindsay, Rebecca, Climate Change: Atmospheric Carbon Dioxide, National Oceanic and Atmospheric Administration (February 20, 2020). See <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide>
- 3 Environmental Protection Agency, Greenhouse Gas Emissions: Understanding Global Warming Potentials, See <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>
- 4 Environmental Protection Agency Center for Corporate Climate Leadership, Atmospheric Lifetime and Global Warming Potential Defined Atmospheric Lifetime. See <https://www.epa.gov/climateleadership/atmospheric-lifetime-and-global-warming-potential-defined>
- 5 Environmental Protection Agency, Greenhouse Gas Emissions: Understanding Global Warming Potentials, See <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>
- 6 David Wallace-Wells, The Uninhabitable Earth, p. 4 (Tim Duggan Books, New York 2019).
- 7 CO₂ Earth, Are We Stabilizing Yet? See <https://www.co2.earth/>
- 8 Jones, Nicola, How the World Passed a Carbon Threshold and Why It Matters, Yale Environment 360 (January 26, 2017). See <https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters>
- 9 Dr. Titley's comments in an editorial board meeting with the Charleston Gazette and Daily Mail editors, June 12, 2018.
- 10 Kunkel, K.E., et. al, Monitoring and Understanding Trends in Extreme Storms: State of Knowledge. Bulletin of the American Meteorological Society (2013) 94(4), 499-514. <https://journals.ametsoc.org/bams/article/94/4/499/60339/Monitoring-and-Understanding-Trends-in-Extreme>
- 11 Huntington, T.G. Evidence for intensification of the global water cycle: Review and synthesis. Journal of Hydrology (2006) 319(1-4), 83-95. <https://www.sciencedirect.com/science/article/abs/pii/S0022169405003215#:~:text=4.%20Summary%20%20%20Variable%20%20,%20No%20change%20%209%20more%20rows%20>
- 12 Di Liberto, Tom, "Thousand-Year" Downpour led to Deadly West Virginia Flood, NOAA Climate.gov, July 8, 2016. Accessed at <https://www.climate.gov/news-features/event-tracker/thousand-year-downpour-led-deadly-west-virginia-floods>

- 13 Third National Climate Assessment, Figure 2.19: Projected Change in Heavy Precipitation Events, (2014). See <https://nca2014.globalchange.gov/report/our-changing-climate/heavy-downpours-increasing#statement-16556>
- 14 Steelhammer, Rick, Last month was hottest, driest September on record for much of WV, Charleston Gazette-Mail (October 2, 2019).
- 15 Butler, Patricia, et.al. Central Appalachians Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Central Appalachians Climate Change Response Framework Project, United States Forest Service, February 2015. See https://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs146.pdf
- 16 Wolfson, Richard: Earth's Changing Climate. The Great Courses, Chantilly, Virginia, 2007.
- 17 Butler, Patricia, et. al. Op cit.
- 18 Mishkin, Kate, Climate Change Threatens a Giant of West Virginia's Landscape, and It's Rippling Through Ecosystems and Lives, Inside Climate News (November 29, 2019). See <https://insideclimatenews.org/news/21112019/west-virginia-climate-change-red-spruce-allegheny-mountains-species>
- 19 Butler, Patricia, et. al. Op cit.
- 20 Wallace-Wells, David, Op. cid, p. 74.
- 21 Linsey, Rebecca, Sea Level Rise Since 1880, Climate.gov, National Oceanic and Atmospheric Administration (August 30, 2009). See <https://www.climate.gov/print/8438>
- 22 Fourth National Climate Assessment, Volume One, Chapter Two, Section 4, Sea Level Rise (2018). See <https://nca2018.globalchange.gov/chapter/2/>
- 23 Linsey, Rebecca, op. cid. (2009).
- 24 The 2018 State of High Tide Flooding and Annual Outlook, National Oceanic and Atmospheric Administration Tides and Currents. See https://tidesandcurrents.noaa.gov/publications/Techrpt_092_2019_State_of_US_High_Tide_Flooding_with_a_2020_Outlook_30June2020.pdf
- 25 Trombley, J., Chalupka, S. and Anderko, L. Climate Change and Mental Health. AJN The American Journal of Nursing (2017) 117(4), 44-52.
- 26 Environmental Protection Agency, Climate Impacts on Coastal Areas (2017).
- 27 Intergovernmental Panel on Climate Change, Global Warming of 1.5° C (2018). See <https://www.ipcc.ch/sr15/>
- 28 For more information on a Green New Deal see: Carlock, Greg, A Green New Deal: A Progressive Vision for Environmental Sustainability and Economic Stability. Data for Progress (September 2018). See <https://www.dataforprogress.org/green-new-deal-report>
- 29 For more information on Citizens' Climate Lobby's proposal see: <https://citizensclimatelobby.org/>
- 30 Regional Economic Models, Inc. The Economic, Climate, Fiscal, Power, and Demographic Impact of a National Fee-and-Dividend Carbon Tax, Washington, DC (2014). See <https://11bup83sxdss1xe1i3lpol4-wpengine.netdna-ssl.com/wp-content/uploads/2018/05/The-Economic-Climate-Fiscal-Power-and-Demographic-Impact-of-a-National-Fee-and-Dividend-Carbon-Tax-5.25.18.pdf>
- 31 Climate Reality Project, Three Big Ways Cities Can Protect Low-Income Residents from Climate Change. (June 2018). See <https://www.climateRealityProject.org/blog/three-big-ways-cities-can-protect-low-income-residents-climate-change>
- 32 The Environmental, Economic and Health Impact of Carbon Fee and Dividend, Citizens' Climate Lobby. See <https://citizensclimatelobby.org/remi-report/>
- 33 For more information on Climate Leadership Council's proposal see: <https://clcouncil.org/>
- 34 Farber, Daniel A. Pollution Markets and Social Equity: Analyzing the Fairness of Cap and Trade, Ecology Law Quarterly, Vol. 39, No. 1 (2012), See <https://www.jstor.org/stable/24113488?seq=1>
- 35 Roberts, David. Gutting fuel economy standards during a pandemic is peak Trump, Vox (April 2, 2020). See <https://www.vox.com/energy-and-environment/2020/4/2/21202509/trump-climate-change-fuel-economy-standards-coronavirus-pandemic-peak>
- 36 Butler, Patricia, et. al. (2018) Op cid.
- 37 Fischetti, Mark, Massive Forest Restoration Could Greatly Slow Global Warming: The right trees, Planted in the Right Locations, Could Store 205 Gigatons of Carbon Dioxide, Scientific America (July 4, 2019).
- 38 Wang, T. Global historical CO₂ emissions 1758-2018, Statista (December 2019). See <https://www.statista.com/statistics/264699/worldwide-co2-emissions/>
- 39 Biello, David, First Look at Carbon Capture and Storage in a West Virginia Coal-Fired Power Plant: The World's first Power Facility to Capture and Store a Portion of Its Carbon Dioxide Has Begun Operating in Appalachia, Scientific America (November 11, 2009). See <https://www.scientificamerican.com/article/first-look-at-carbon-capture-and-storage/>
- 40 Intergovernmental Panel on Climate Change, op cid.
- 41 Boyce, James, Freedom from Fossil Fuels Is Good for Your Health, Institute for New Economic Thinking. (February 2020). See <https://www.ineteconomics.org/perspectives/blog/freedom-from-fossil-fuels-is-good-for-your-health>