



Testimony of Secretary Patrick McDonnell
Department of Environmental Protection
Hearing on CO₂ in Pennsylvania
House Environmental Resources and Energy Committee
Monday, October 28, 2019

Good morning Chairman Metcalf, Chairman Vitali, and members of the committee. On behalf of Governor Wolf, I'd like to thank you for the opportunity to testify regarding undeniable impact that human activity is having on the temperature of the globe. I provided testimony to this committee last month and I encourage you to refer to that for additional information on what the Governor is doing to address a changing climate.

As a refresher, climate change has led to more flooding, more heat and respiratory illnesses, more vector-borne diseases and pests, and more disruptions to agricultural systems right here in Pennsylvania. Since 1900, Pennsylvania has warmed by 1.8 degrees F. Annual precipitation has increased 10% on average, with some areas seeing a 20% increase over the same time period. From 1958 through 2010, the Northeast U.S. saw more than a 70% increase in the amount of precipitation falling during very heavy events.

The impacts of climate change are vast and what was predicted 10 years ago is being confirmed today. The projections are even more dire. By 2050, Pennsylvania is expected to warm by 5.4 degrees F. The Pennsylvania that we know will not be the same Pennsylvania that our children or our grandchildren will know. By the middle of this century, Philadelphia will feel like Richmond and Pittsburgh will feel like Washington, D.C. Precipitation patterns will also be increased by another 8% by 2050, with a winter precipitation increase of 14%.

We know that climate change impacts are being caused by the emission and atmospheric concentration of greenhouse gases, namely Carbon Dioxide (CO₂) and Methane (CH₄). There is overwhelming scientific evidence that these greenhouse gas emissions are causing climate change, with modeling and prediction of impacts improving rapidly.

The Greenhouse Gas Effect

Solar energy absorbed at the Earth's surface is radiated back through the atmosphere and back to space. The surface temperature of the Earth depends on this balance of incoming and outgoing

solar radiation. The problem is when CO₂ (or other GHG) molecules absorb that energy and re-emit another infrared (IR) photon back to the surface. This absorption and re-emitting of infrared energy is what makes certain gases cause “the greenhouse effect” which traps heat in the lower atmosphere, not allowing it to go back out to space. Not all gas molecules are able to absorb and re-emit IR radiation, simpler molecules - such as nitrogen or oxygen, are not considered greenhouse gases. Greenhouse gases like CO₂ and methane take decades or even centuries to leave the atmosphere. The main source of these greenhouse gases is from the burning of fossil fuels.

The atmosphere, however, is not the only place that carbon pollution is going. In fact, about 48% of the carbon emitted into the atmosphere by burning fossil fuels is sequestered into the ocean. This is why oceans are called “carbon sinks”, as they contain approximately 50 times more carbon than that in the atmosphere¹. Recently, oceans have been absorbing carbon at an alarming rate. The National Oceanic and Atmospheric Administration states that the amount of carbon absorbed by oceans between 1994 and 2007 is a fourfold increase from the amount absorbed between 1800 and 1994².

The dramatic increase in carbon absorbed by oceans is having devastating impacts. Higher levels of carbon dioxide in the ocean leads to ocean acidification and expansion of depleted oxygen zones, resulting in a decreased ability of underwater ecosystems, such as coral reefs, to survive. As the oceans absorb carbon, they are also absorbing much of the extra warming due to the greenhouse effect. Warming oceans is leading to more extreme weather events and melting of glacial ice³.

The challenges with carbon sinks are expected to worsen over time. The oceans can only absorb so much carbon dioxide and recent studies have shown that some oceanic carbon cycles are being disrupted due to warmer temperatures⁴. For example, an MIT study found that organisms near the ocean surface that take atmospheric carbon and draw it into the ocean floor do so at a decreased rate in warmer waters. The amount of carbon not sinking because of this one impact alone is massive - approximately equal to the amount of carbon emissions that the United Kingdom emits annually⁵.

History of Climate Change Research

It appears that the first scientific venture into climate research came in 1896, when Svante Arrhenius, a Swedish scientist used basic principles of chemistry to estimate that carbon dioxide use would increase the Earth’s surface temperature. In November 1965, Lyndon B. Johnson received a report from the Environmental Pollution Panel of President’s Science Advisory Committee that sounded the alarm on carbon pollution based on nearly three dozen scientific papers done in the 50s and 60s. That report told us nearly 54 years ago that “within a few short centuries, we are returning to the air a significant part of the carbon that was extracted by plants and buried in the sediments during half a billion years.” It further stated, “the climate changes

¹ <https://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-carbon-cycle>

² <https://www.ncei.noaa.gov/news/global-ocean-absorbing-more-carbon>

³ <https://www.iucn.org/resources/issues-briefs/ocean-and-climate-change>

⁴ <https://www.ipcc.ch/site/assets/uploads/2018/02/TAR-03.pdf>

⁵ <https://aslopubs.onlinelibrary.wiley.com/doi/10.1002/lol2.10042>

that may be produced by the increased CO₂ content could be deleterious from the point of view of human beings.” Later that year, LBJ told Congress: "This generation has altered the composition of the atmosphere on a global scale through ... a steady increase in carbon dioxide from the burning of fossil fuels."

We also know that major fossil fuel corporations have known about human-caused climate change for decades. In 1979, Exxon Mobile drafted an internal memo that stated:

"Models predict that the present trend of fossil fuel use will lead to dramatic climatic changes within the next 75 years Should it be deemed necessary to maintain atmospheric CO₂ levels to prevent significant climatic changes, dramatic changes in patterns of energy use would be required."

In 1982, Exxon’s manager of their Environmental Affairs Program sent a memo to their management team, including a technical review, that the Earth’s CO₂ concentration was 340 ppm and that combustion of fossil fuels and reduction in the amount of worldwide forests were contributing to the concentration of greenhouse gases in the atmosphere. He estimated that doubling the current concentration could lead to an increase in average global temperature by 1.3 degrees C to 3.1 degrees C.

In 1988, Shell projected similarly, and found that CO₂ concentrations could double by 2030. Their Greenhouse Effect Working Group authored a confidential report that detailed potential climate impacts: sea level rise, human migration, and ocean acidification. The report was explicit: “Although CO₂ is emitted to the atmosphere through several natural processes... the main cause of increasing CO₂ concentrations is considered to be fossil fuel burning.” Their report provided a recommendation to take policy action, before climate change was observed. They also acknowledged that by the time that global warming would be detectable, it could be too late to take action to reduce the effects.

As it turns out, they all were correct.

Scientific Consensus

In science, when overwhelming evidence points toward one theory versus the alternatives, the theory becomes valid. Smoking cigarettes causes cancer. The Earth isn’t flat. Vaccines don’t cause autism. And climate change is caused by human activity and is an existential threat to life on Earth. We have arrived at these conclusions because the scientific evidence supporting these hypotheses far outweighs the evidence to the contrary. Especially when that research is independent across multiple disciplines- like climatologists, geologists, oceanographers, archaeologists, physicists, marine biologists, ecologists, doctors, botanists, chemists, meteorologists, virologists, zoologists, conservation biologists, microbiologists, and paleontologists. It is the breadth of virtually the entire scientific community across the entire world. The scientific consensus on anthropogenic climate change is stronger than the scientific consensus that smoking causes cancer.

In my previous testimony, I listed several health organizations that have sounded the alarm on climate impacts. Similarly, the following scientific organizations all agree that human activities are causing planet-warming:

- American Association for the Advancement of Science
- American Chemical Society
- American Geophysical Union
- American Medical Society
- American Meteorological Society
- American Physical Society
- The Geological Society of America
- U.S. National Academy of Sciences

Worldwide, there are hundreds of scientific organizations that agree that human activities are causing climate change.⁶

Similarly, the latest National Climate Assessment issued by the Trump Administration was developed with more than 300 experts and a 60-member Federal Advisory Committee and reviewed extensively by the public and experts, including a panel of the National Academy of Sciences. That report attributes most of the warming of the past century to human activities. Further, it states that “There is very high confidence that the global climate change of the past 50 years is primarily due to human activities, given the evidence base and remaining uncertainties. Recent changes have been consistently attributed in large part to human factors across a very broad range of climate system characteristics.” A very high confidence level in the scientific community is the highest confidence level you can get. It shows strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.) with high consensus.

Luckily for us, the scientific process is designed to have scientists test and contest each other’s conclusions. It is just simply unrealistic to believe that there is a conspiracy where 97% of climate scientists are propelling a fake agenda. Those that understand the scientific process will appreciate how difficult it would be to have virtually all of the scientists from around the world involved in a massive hoax.

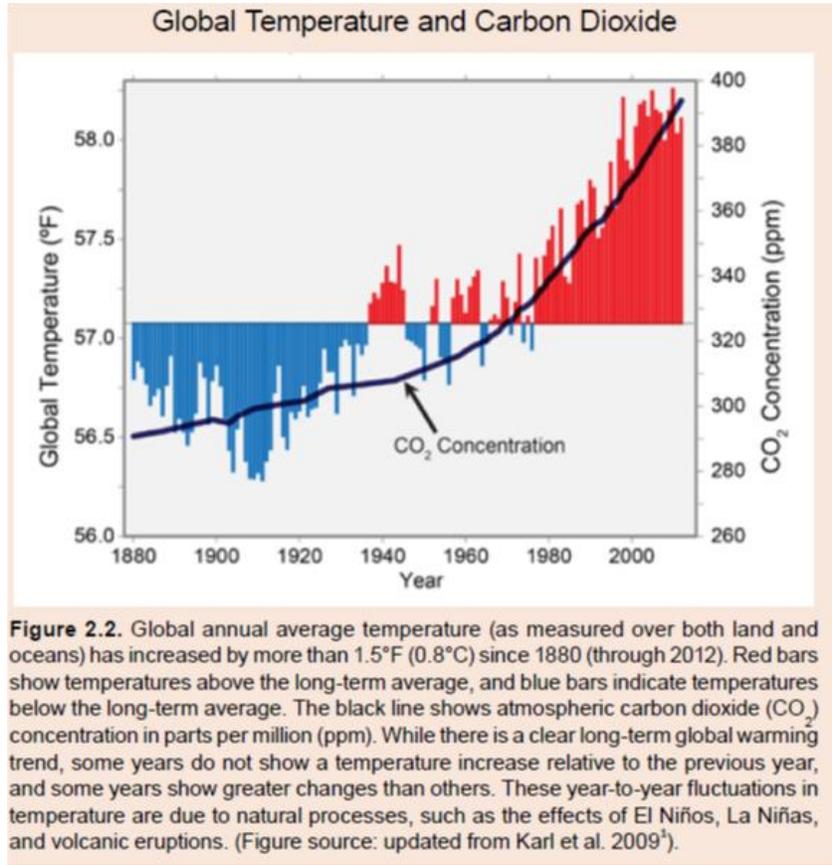
Common Misconceptions

It’s no secret that there are some common misconceptions and misrepresentations regarding climate change and the supporting science. The strategy, tactics, and rhetoric used by climate deniers is similar to those used by tobacco lobbyists to spread disinformation and confuse the connection between smoking and cancer. As climate science has emerged and strengthened, the consensus has been attacked and the uncertainties exaggerated. These misrepresentations, exaggerations of uncertainty, and disinformation have served one purpose: to confuse the public and policy makers for the purpose of delaying real action that addresses climate change.

One major misconception or misrepresentation is that the science about the cause of climate change is uncertain. NASA – the same organization that sent humans to the moon and explored Mars with a rover - estimates that 97 percent or more of actively publishing climate scientists agree that the climate warming trends over the past century are extremely likely due to human activities. If today’s meeting were divided to reflect the overwhelming consensus of research from the scientific community, those that acknowledge human activities – like burning fossil fuel

⁶ Many of them are listed at <http://www.opr.ca.gov/facts/list-of-scientific-organizations.html>.

- is causing the planet to warm would be given two hours and 54 minutes of a three-hour meeting to explain the science of climate change. Those that contest the overwhelming scientific consensus would be given less than 6 minutes to refute the evidence.



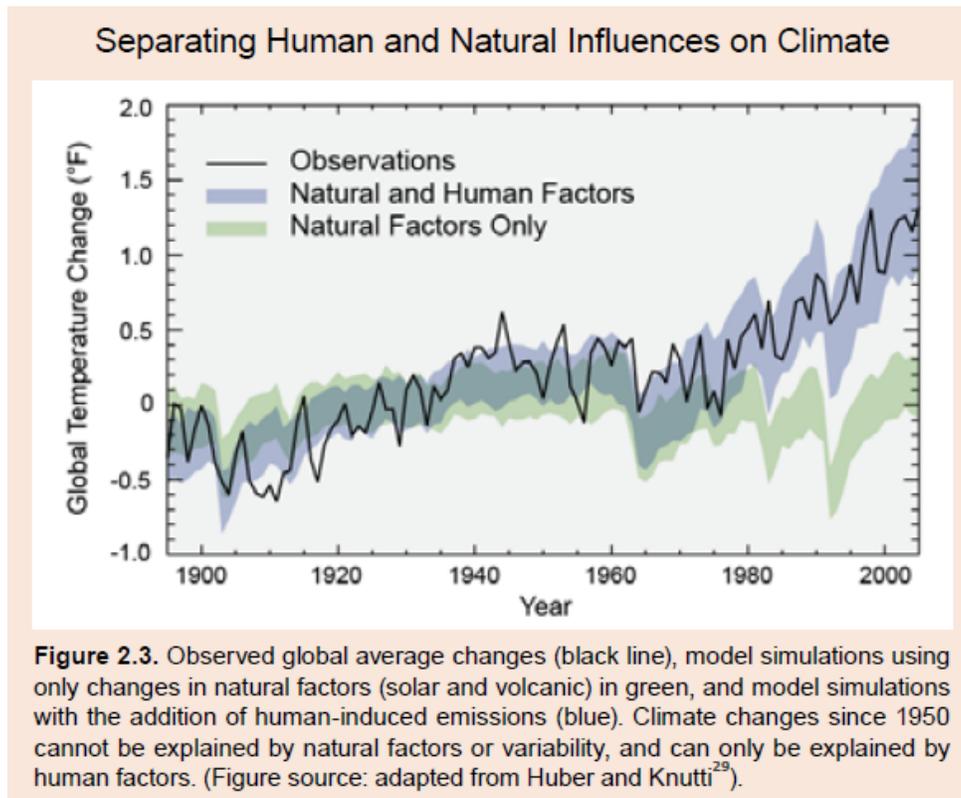
Source: Fifth National Climate Assessment (2019) pp. 23

Another misconception, misrepresentation, or half-truth is that the Earth has always warmed and cooled, that this is all just part of the natural planetary cycle. It is true that the Earth goes through various cycles that can impact climate and the amount of carbon dioxide in the atmosphere, such as orbital cycles, sun activity, and others. For example, Chicago was under mile high ice sheets 20,000 years ago when atmospheric carbon dioxide concentrations were 200 parts per million.

Due to a slow natural increase of 100 parts per million in atmospheric carbon dioxide, over about 8,000 years, those ice sheets are now gone. However, in the last 100 years, humans have added another 120 parts per million of carbon dioxide to our atmosphere. In other words, humans are drastically changing the chemical makeup of the planet quicker than any natural cycle ever has.

The most recent National Climate Assessment states “A substantial body of analysis comparing the observed changes to a broad range of climate simulations consistently points to the necessity of invoking human-caused changes to adequately explain the observed climate system

behavior.”⁷⁸ The graph below provides the visual evidence from the Fifth National Climate Assessment.



Source: Fifth National Climate Assessment (2019) pp. 23

Another misconception, misrepresentation, or half-truth is that greenhouse gases are good for the planet and we need them for life to exist, therefore there’s nothing to worry about. It is true that greenhouse gases are important for the Earth’s climate. Without them, our planet would be a ball of frozen ice. However, just like eating too many calories or sending too many nutrients to our local waterways - there’s a problem with too much of a good thing. For example, researchers have found that higher concentrations of carbon dioxide are leading to significantly reduced nutritional value in many staple crops that humans depend on. Rice⁹, wheat, soybeans, and others have shown decrease levels of protein, iron, and zinc – critical nutrients for humans¹⁰. This is

⁷ Gillett, N. P., V. K. Arora, G. M. Flato, J. F. Scinocca, and K. von Salzen, 2012: Improved constraints on 21st-century warming derived using 160 years of temperature observations. *Geophysical Research Letters*, **39**, 5, doi:10.1029/2011GL050226. <https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2011GL050226>

⁸ Stott, P. A., N. P. Gillett, G. C. Hegerl, D. J. Karoly, D. A. Stone, X. Zhang, and F. Zwiers, 2010: Detection and attribution of climate change: A regional perspective. *Wiley Interdisciplinary Reviews: Climate Change*, **1**, 192-211, doi:10.1002/wcc.34.

⁹ <https://advances.sciencemag.org/content/4/5/eaq1012>

¹⁰ <https://news.harvard.edu/gazette/story/2014/05/rising-co2-poses-significant-threat-to-human-nutrition/>

just another example of the massive disruption of the carbon cycle is increasingly impacting humans and life on earth.

Another common talking point of the 3% of climate deniers is that CO₂ concentrations in the atmosphere have never been lower. The National Oceanic and Atmospheric Administration states that the global average atmospheric carbon dioxide in 2017 was 405.0 parts per million. Carbon dioxide levels today are higher than at any point in at least the past 800,000 years. The last time there is any record of atmospheric carbon dioxide concentrations being this high, over three million years ago, it was about four degrees warmer and sea levels were 50-80 feet higher.¹¹

In the last 150 years, atmospheric carbon dioxide levels have nearly doubled, due to the growth of modern civilization, which has depended on a range of industrial activities. For example, burning of fossil fuels for energy, such as electricity and transportation, increases greenhouse gases. Clearing of forests, which reduces the amount of greenhouse gas sinks, leads to increases in the concentration of these gases. Most greenhouse gases take decades to break down and leave the atmosphere, meaning we will be seeing the impacts of our current emissions for years to come.

The final misconception or misrepresentation I'll note is that people believe climate change isn't happening because it's still cold outside. People often confuse the weather with climate. They are related, but they are different. Weather is often defined as the daily state of the atmosphere at any given location and its short-term variation throughout the day. Climate, however, is characterized by the type, frequency, duration, and intensity of weather over a period of time, often 30 years. Scientists study climate by looking at variability or trends in temperature, precipitation, etc. One way to think about it is to consider weather as your mood throughout the day, while climate could be considered your personality over time.

It is important to note that as it is true that because it is cold outside does not mean climate change isn't happening, it is also true that every extreme weather event is not attributable to climate change. Climate change is altering the type, frequency, duration, and intensity of weather. For example, there have been hurricanes in the Atlantic for hundreds of years, but climate change is likely making Atlantic hurricanes more frequent and more intense¹². There are a number of other potentially devastating impacts to weather due to climate change that will occur across the globe if greenhouse gas emissions are not reduced.

Deniers of basic scientific principles have been using these climate misconceptions, combined with people's fear of change, to fuel public confusion and policy maker's avoidance of addressing the issue.

The concept of climate change can be difficult for people to grasp when impacts seem distant – either by time or geographic location. This can leave them feeling apathetic to the issue, or worse

¹¹ <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide>

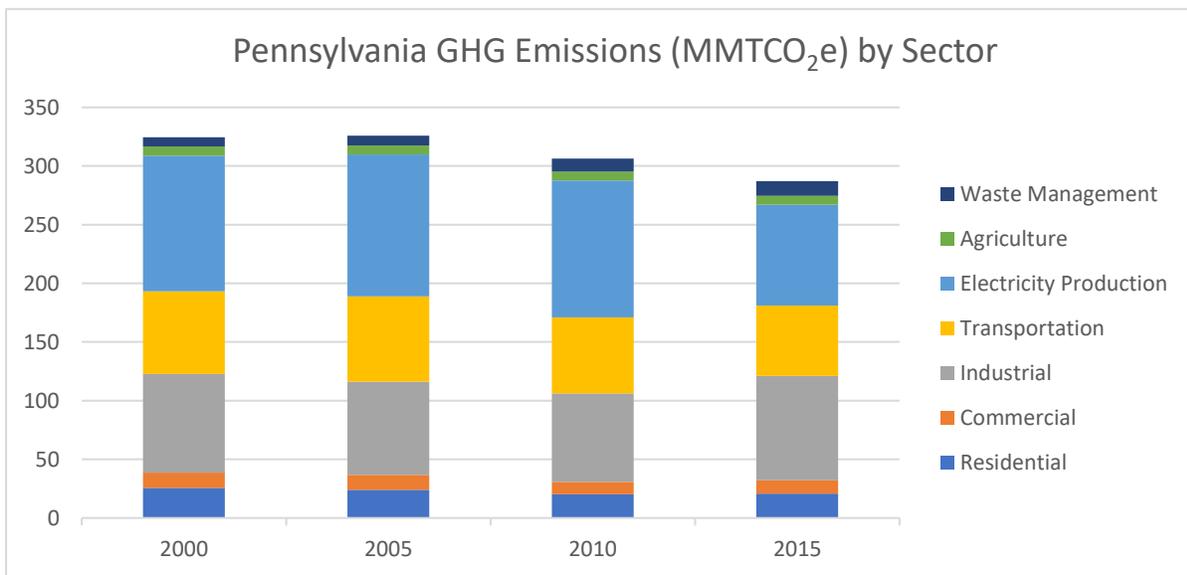
¹² <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>

– to believe it to be a partisan political discussion and not one explained by science to be solved by science. However, when they see their homes, places they love, or places that have a special meaning to them being changed by extreme weather events, it becomes more tangible for them.

Last month, Yale released their latest climate opinion maps for 2019 and it shows that 2/3 of all Pennsylvanians believe that global warming is happening. This percentage has steadily increased throughout the years as we're now living with the impacts of climate change.

Pennsylvania's Greenhouse Gas Inventory

The Pennsylvania Climate Change Act (Act 70 of 2008) requires DEP to produce an inventory of greenhouse gas emissions within the state. The good news is that GHGs are decreasing, the bad news is that they aren't decreasing fast enough and are actually projected to increase.



Pennsylvania's greenhouse gas emissions come from a number of different sectors, including residential, commercial, industrial, transportation, electricity production, agriculture, waste management, and forestry and land use. According to DEP's most recent Greenhouse Gas Inventory, the total statewide net GHG emissions for Pennsylvania were 257 million metric tons of carbon dioxide equivalents (MMTCO₂e).

The sectors with the largest contribution to the Commonwealth's GHG emissions are the transportation, industrial, and electricity production sectors, all of which combine to account for approximately 82 percent of Pennsylvania's gross emissions. Recently, we have seen the industrial sector, which includes natural gas production and coal mining, become the leading emissions producing sector. Historically, the electricity sector was the leading emissions source but has recently seen decreasing emissions primarily due to flat electricity demand and fuel switching at power plants from coal to natural gas.

Overall, Pennsylvania's emissions have shown a relative decrease of 12 percent in net emissions from 2005 to 2015¹³. This is a good start, but it's still not enough. DEP projects overall emissions to increase from 2015 levels by 2025 and even more so by 2050 if no additional policies are implemented¹⁴. These projected increases are due to expected closing of some nuclear power plants, which do not produce any carbon emissions, and a slowdown of fuel switching from coal to natural gas. Greenhouse gas emissions must decrease further, not increase, if we are to have any hope of effectively mitigating anthropogenic climate change. It was in that spirit that Governor Wolf signed Executive Order 2019-01, which states that Pennsylvania shall strive to reduce net greenhouse gas emissions 26 percent by 2025 from 2005 levels, and 80 percent by 2050 from 2005 levels. If all states achieved similar GHG reduction targets, and other nations met comparable goals, climate science analysis suggests that global temperature rise could be kept below the 2-degree Celsius threshold cited by experts as the level beyond which dire consequences would occur, including sea level rise, superstorms, and crippling heat waves.

There are some who may agree that humans are causing climate change but question why Pennsylvanians should take action, especially given that we account for approximately one percent of worldwide emissions and other national or sub-national governments may not be taking action. However, that is simply not true. The Paris Agreement was signed by nearly every country in the world and most are already implementing the actions they committed to doing. This is significant as the Federal Government has re-committed to withdrawing the country from the agreement. Per person, the United States ranks tenth for the highest greenhouse gas emissions in the world.

As one of the top GHG emitting states in the country, Pennsylvania has an obligation to take action to reduce greenhouse gas emissions. In fact, in just the time since I last testified to this committee about a month ago, Pennsylvania has emitted emissions approximately equal the yearly emissions of Delaware, Vermont, and Rhode Island combined. Pennsylvania is a major source of emissions and has a duty to act to combat climate change.

Regional Greenhouse Gas Initiative (RGGI)

One promising opportunity for Pennsylvanians to combat climate change is in clean electricity generation. Clean energy jobs now account for one out of every three energy jobs in Pennsylvania and employs more than twice the number of workers as Pennsylvania's entire fossil fuel industry¹⁵. Pennsylvania is the third highest electricity generating state in the nation and the top electricity exporter. This means that the Commonwealth generates more electricity than it consumes, and the remaining amount is used in other states. Fifty-seven percent of Pennsylvania's electricity comes from coal and natural gas, so there are significant opportunities to reduce emissions from the electricity generation sector.

¹³ [DEP Greenhouse Gas Inventory](#)

¹⁴ [DEP Climate Action Plan](#)

¹⁵ <https://www.e2.org/reports/clean-jobs-pennsylvania-2019/>

Earlier this month, Governor Wolf's Executive Order directed DEP to begin a rulemaking process that will allow Pennsylvania to join the Regional Greenhouse Gas Initiative, with the goal of reducing carbon emissions from the electricity sector.

RGGI is composed of individual carbon budget trading programs in each state, based on each state's independent legal authority. RGGI provides a "model rule" for each state to adopt independently that then "links" with other states to allow for the interstate buying, selling, and trading of auction credits. This allows states to essentially regulate independently, while it increases the supply of available credits to level the price.

Pennsylvania would first set a limit on the amount of carbon pollution that power plants are allowed to emit and sell pollution permits up to this limit through quarterly auctions administered by RGGI Inc. The program would require large carbon-emitting power plants to buy pollution credits from the auction and the number of credits auctioned is lowered each year. One credit is typically equal to one ton of carbon pollution. In August 2017, the RGGI states announced a commitment for an additional 30 percent cap reduction by the year 2030, relative to 2020 levels.

The RGGI states have reduced power sector CO₂ pollution over 45 percent since 2005, while the region's per-capita GDP has continued to grow. RGGI-funded programs also save consumers money and help support businesses.

- RGGI investments in 2015 are estimated to return \$2.31 billion in lifetime energy bill savings to more than 161,000 households and 6,000 businesses which participated in programs funded by RGGI investments.
- 1.5 million households and over 37,000 businesses which received direct bill assistance. Clean and renewable energy makes up 16 percent of 2015 RGGI investments and 14 percent of cumulative investments.
- RGGI investments in these technologies in 2015 are expected to return \$785.8 million in lifetime energy bill savings to 19,600 participating households and 122 businesses in the region.
- RGGI-driven reductions in pollutant emissions have resulted in over \$5.7 billion in health and productivity benefits in the states participating in RGGI.

RGGI is a well-established and active carbon trading mechanism for which all the Northeast and most of Pennsylvania's neighboring states are participating, which is an example of a successful market-based program that has significantly reduced and continues to reduce emissions through a carbon pricing mechanism.

Governor Wolf's Executive Order directs DEP to develop and present a regulation to the Environmental Quality Board by July 31, 2020. The regulatory process will include significant opportunity for engagement by the General Assembly, key stakeholders, and residents of Pennsylvania who by a wide margin support the state taking concrete steps to address climate change. In fact, Yale studies show that nearly 70% of Pennsylvanians think global warming will harm future generations and 78% of Pennsylvanians support regulating CO₂ as a pollutant.

Looking forward, assuming the Environmental Quality Board adopts the proposed rulemaking, the regulation will be enacted consistent with the requirements of the Regulatory Review Act, which can take upwards of two years.

Opponents of RGGI state that this is a carbon tax or a new government price on carbon. The reality is that there is already a price on carbon, it's just that the wrong people are paying it. With RGGI, electricity generators incorporate the price of carbon pollution into their product. This is in contrast to the current system – in which residents of Pennsylvania are paying for the pollution through worsened air quality, increased health care costs, and climate change impacts to infrastructure, agriculture, and more.

Developing a regulation that links with RGGI states is one of many actions that we plan to take to combat climate change. The impacts of climate change are real and will continue to put Pennsylvanians at risk from increased flooding, higher temperatures, and more. These impacts can be alleviated if all Pennsylvanians—including citizens and businesses, but especially leadership—understand their responsibility to combat and adapt to climate change and take action. The benefits of acting include economic growth, jobs, cleaner air, resilience and more. Pennsylvanians want to provide a prosperous commonwealth with clean air, water, and land for generations to come, now is the time to take action on climate change.

Thank you again for inviting DEP to testify before the committee on this important topic. I am available to respond to any questions you may have.