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ISSUE BRIEF

CLIMATE CHANGE AND HEALTH IN PENNSYLVANIA

Climate change is altering seasonal temperature and precipitation patterns, making hot days hotter and increasing the frequency of extreme weather events like the record-breaking rain that flooded large swaths of Pennsylvania in August 2018.[1] As a result, Pennsylvanians face a variety of health threats including more heat-related illnesses, breathing and heart problems, food and water contamination, and increased exposure to infectious diseases.[2] These threats will only increase as power plants, transportation systems, and other big polluters continue to pump climate-changing emissions into the air.

Pennsylvanians can protect themselves from these impacts by implementing cleaner and more efficient energy policies and preparing more effectively for future climate-related health challenges.[3] Pennsylvania's communities and health departments must also have the resources and capacity to deal with present-day health threats.[4]

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A truck travels through a flooded road in Pennsylvania.

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MORE SEVERE FLOODS THREATEN AIR AND WATER QUALITY AND EMERGENCY SERVICES IN PENNSYLVANIA

In addition to damaging homes and disrupting lives, floods can lead to numerous widespread health risks such as exposure to hazardous mold and contaminated water. Pennsylvania has about 86,000 miles of streams and rivers and historically has been one of the most vulnerable states in the country to flooding.[5] Of the commonwealth's 67 counties, 51 have had at least one federal disaster declaration for hurricanes, severe storms, or other flooding since 2011, and some have had as many as six.[6]

As the global climate warms, many parts of the state will face more frequent and severe floods due to heavier rain and sea level rise. About a third of Pennsylvania has seen a 5 to 10 percent increase in annual average precipitation from the early 20th century (1901 to 1960) to recent decades (1986 to 2015).[7] Days with extreme rainfall (the top 1 percent of days at a given location with the most rain) have also increased in parts of the state. From 1979 to 2014, the annual frequency of extreme rainfall events and the annual daily maximum rainfall (the highest one-day precipitation amount in a given year) increased in central and northeastern Pennsylvania.[8] July 2018 was Pennsylvania's wettest month on record; the resulting severe flooding prompted evacuations and water rescues in several communities.[9] Severe floods that historically had a 1 percent chance of occurring in any given year, known as 100-year floods, are expected to become more common.[10] Between 2040 and 2060, a combination of projected changes in rainfall and runoff could increase the frequency of 100-year floods by more than 150 percent across much of eastern Pennsylvania, relative to the period from 1950 to 2000.[11]

The Delaware River, which marks Philadelphia's eastern border, is tidal, meaning its flow and water level are affected by sea level rise.[12] The average sea level at Philadelphia's tide gauge has increased by more than 11 inches in the past 100 years, which is substantially higher than the global average of 7 to 8 inches.[13] This water level rise has already increased the number of days with nuisance flooding (sometimes called "sunny day" flooding) in Philadelphia.[14] From 1950 to 2014, roughly 53 percent of days with nuisance flooding in the city would *not* have occurred without human-caused sea level rise. Looking only at more recent years, from 2005 to 2014, an estimated 69 percent of days with nuisance flooding would have been avoided if not for human-caused sea level rise.[15]

Health hazards from indoor mold will increase as climate change boosts the number and severity of rainstorms and floods in Pennsylvania.[16] Indoor mold can cause or exacerbate asthma in children, may contribute to the development of asthma in adults, and can worsen other respiratory symptoms such as nasal congestion.[17] Mold exposure poses a particular threat to people with chronic lung diseases, such as chronic obstructive pulmonary disease (COPD), and those with suppressed immune systems, such as cancer patients receiving chemotherapy.[18]

The brunt of these health hazards will fall more heavily on people who live in low-quality housing or who can't afford repairs in the aftermath of heavy rain or flooding; in Pennsylvania, that means disproportionately Black residents. Housing with major structural deficiencies, such as cracks in the foundation or walls or insufficient heating or cooling, are more prone to water damage during storms and more susceptible to mold growth.[19] In 2015, homes in Pennsylvania occupied by Black householders (renters or owners of record over the age of 15) were more than twice as likely to have moderate to severe structural deficiencies than homes occupied by white householders.[20]

Increases in extreme precipitation and flooding will also likely lead to more contaminated runoff from streets and farms, and more failures of Pennsylvania's aging drinking water, stormwater, and wastewater systems.[21] Contaminated runoff and sewer leaks or overflows can spread disease among communities; in fact, heavy precipitation preceded more than two-thirds of waterborne disease outbreaks, such as the diarrheal illness giardiasis, in the United States from 1948 to 1994.[22]

Combined sewer systems, which carry sewage and stormwater in the same network of pipes, are common across 39 of Pennsylvania's 67 counties.[23] These outdated systems were designed to overflow into lakes, rivers, and streams during heavy rain or snowmelt. After heavy rain in the summer of 2016, popular swimming, fishing, and paddling creeks in Cumberland and Dauphin Counties contained 10 times the U.S. Environmental Protection Agency's maximum acceptable level of *E. coli* bacteria.[24] The most common strains of *E. coli* can cause stomach cramps, vomiting, and diarrhea and in some cases can require hospitalization or become life threatening.[25]

Flooding can also disrupt emergency health and safety services by blocking roads and damaging critical facilities. In July 2018, central Pennsylvania experienced historic flooding after more than one foot of rain fell over five days. The storm closed 120 state roads, left 3,000 Pennsylvanians without power, and killed two people attempting to escape the rapidly rising waters.[26] Currently 30 percent of Philadelphia's expressways and 18 percent of the city's major roads are in areas that could be inundated by a 100-year flood.[27]

Low-income, elderly, or disabled people are less likely to receive timely flood warnings and can have difficulty evacuating during flood emergencies.[28] Although we do not see a higher concentration of older adults or people experiencing poverty living in floodplain areas statewide, highly vulnerable populations are disproportionately represented in flood zones in some individual communities.[29] For example, in Easton, in Northampton County, the downtown area is the most vulnerable neighborhood in the city to flooding because of its proximity to the Lehigh and Delaware Rivers, low elevation, and abundance of impervious surfaces that contribute to runoff.[30] The downtown area also contains one of the roads

A woman tries to shield herself from the sun while walking in sweltering heat on July 1, 2018 in Philadelphia, Pennsylvania.

most at risk of flooding in Pennsylvania and a major mass transit terminal. Unfortunately, the area also houses some of the city's highest proportions of people with disabilities and adults aged 65 or older, who may have mobility challenges or be unable to drive.[31]

EXTREME HEAT IS BAD FOR PENNSYLVANIANS' HEALTH—AND COULD BECOME MORE DEADLY

Pennsylvania summers are getting longer and hotter because of climate change and could become even more dangerous in just a few decades.

In Pennsylvania, average annual temperatures have climbed about 1.4 degrees Fahrenheit since 1895.[32] More than 4.9 million Pennsylvania residents—about 39 percent of the total population—lived in counties that experienced an average of greater than two weeks' worth of extreme heat days per summer from 2007 to 2016 (Figure 1).[33] That's 57 to 131 percent more days than expected from local historical averages.[34] By 2080, Allentown and Pittsburgh could feel more like Jonesboro, Arkansas, does today.[35]

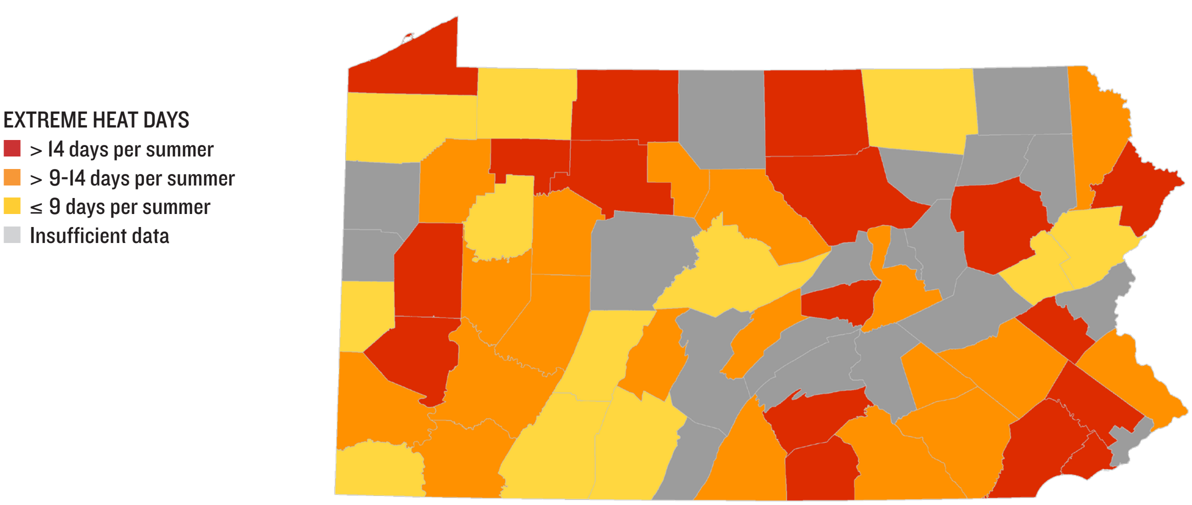
Between 1997 and 2004, an average of 50 people per year in Pennsylvania died from extreme heat, making it more lethal in the state than all other natural disasters combined.[37] Heat and humidity also pose a range of nonfatal threats to Pennsylvania residents, from minor illnesses such as heat cramps to more severe conditions like heat-related heart problems and heatstroke.[38] As temperatures continue to rise, Pennsylvania can expect to see more heat-related deaths and illnesses throughout the state.

Anyone can get sick from extreme heat, but outdoor workers, young children, pregnant women, older adults, people with chronic diseases like diabetes, and people experiencing poverty are particularly vulnerable.[39] Heat vulnerabilities associated with age, occupation, and socioeconomic factors can be more pronounced in cities, which are warmer than surrounding areas because of the urban heat island effect.[40] This phenomenon, which adds to the warming caused by carbon pollution, is caused by elements of the urban built environment, such as an abundance of heat-absorbing surfaces (like asphalt) and tall buildings that block airflow.[41] In the city of Philadelphia, for instance, daily summer temperatures from 2004 to 2013 were an average of 3.8 degrees Fahrenheit higher than in nearby rural areas.[42] Compounding this, recent studies of Philadelphia found that low-income neighborhoods with higher concentrations of people of color are more likely to have vacant lots (which are hotter on average than parks, even if they have vegetation) and less likely to have street trees (which provide shade) than wealthier, whiter neighborhoods.[43]

Additionally, low-income households may be unable to afford life-saving air-conditioning.[44] In Philadelphia, low-income households of color have a higher energy burden, defined as the proportion of household income that goes to energy bills.[45] Latino and low-income households in

FIGURE 1. AVERAGE NUMBER OF EXTREME HEAT DAYS EACH YEAR IN PENNSYLVANIA COUNTIES, 2007–2016

"Extreme heat days" are defined as June, July, and August days from 2007 to 2016 on which the maximum temperature at a given weather station fell within the top 10 percent of readings at that station, based on local temperatures from 1961 to 1990. Nine extreme heat days per summer, on average, would be expected if temperatures were not increasing over time. More details on methodology and data sources can be found in NRDC's 2017 "Climate Change and Health: Extreme Heat" map.[36]




Philadelphia's skyline seen through haze from Belmont Plateau.

Philadelphia have a median energy burden of 7.3 and 8.8 percent, respectively, compared with 3.8 percent for all Philadelphia households. With increased heat, urban dwellers, communities of color, and low-income communities will disproportionately feel the health impacts.

CLIMATE CHANGE PUTS PENNSYLVANIA'S PROGRESS TOWARD CLEANER AIR AT RISK

Smog is a form of air pollution that exacerbates asthma and other lung conditions and is linked to other serious health problems like cardiac arrest, memory disorders, and birth defects.[46] Ground-level ozone, the main ingredient of smog, is formed when sunlight and heat chemically react with pollution from sources such as vehicles, power plants, and natural gas wells.[47] Hot weather can speed up those smog-forming chemical reactions, meaning that rising temperatures associated with climate change will increase smog production.[48]

Pennsylvania's air quality has improved in recent decades, largely because of federal pollution limits.[49] For example, in 2005 ozone concentrations exceeded federal pollution limits at 97 percent of the monitoring stations across Pennsylvania. In 2016, however, ozone exceeded limits at just 7 percent of stations.[50] Unfortunately, the combination of climate change and the expansion of Pennsylvania's natural gas industry could undermine the state's progress toward cleaner air and make it harder to meet air quality standards in the future.[51]

In 2016, an estimated 235,000 children and 1 million adults in Pennsylvania had asthma, a chronic lung disease that can be triggered by smog.[52] Asthma is already an expensive condition to treat: in 2012 it cost $980 to treat the average asthma patient in Pennsylvania, and asthma-related absences from work and school cost the state $92.4 million.[53] The personal burden of deteriorating air quality will fall heavily on low-income families and children of color, in part because of their proximity to local sources of pollution.[54] Data collected between 2008 and 2012 indicate that half of the state's major fossil fuel plants are located within three miles of a community where at least 20 percent of residents live in poverty and/or where at least 30 percent of residents are people of color.[55] In Pennsylvania, Black residents were also five times more likely than white residents to be hospitalized for asthma in 2013.[56]

ALLERGY SEASONS ARE GETTING LONGER AND MORE SEVERE

Seasonal pollen allergies, also known as hay fever, are common across Pennsylvania.[57] Hay fever symptoms such as congestion and headache can range from mildly annoying to downright disruptive, affecting sleep, mood, and quality of life.[58]

Rising temperatures are leading to earlier and longer growing seasons in Pennsylvania, meaning an earlier start to spring allergy season and a potentially longer pollen season overall.[59] In Pittsburgh and Philadelphia, spring (defined in part by temperature thresholds) has started a few days earlier each decade since the late 1940s.[60] From 1970 to 2018, growing seasons across eight Pennsylvania cities got an average of 15 days longer.[61] From 2001 to 2010, the pollen season for five different types of plants started an average of three days earlier than in the previous decade, according to a study of 13 monitoring sites in the northeastern United States.[62] Annual pollen production in the Northeast averaged nearly 38 percent higher in that same period than in the previous decade, potentially due to changes in the pollen season length or the effect of temperature, carbon dioxide, or precipitation on pollen production in individual plants.[63]

The risk of severe asthma attacks increases when there's more pollen in the air. In 2010, asthma triggered by oak and birch pollen led to an estimated 25,000 to 50,000 emergency room visits across the United States, and grass pollen led to approximately 10,000 visits.[64] Climate change can make matters worse. Under a high carbon pollution emissions scenario, emergency rooms across the country could see nearly 3,700 more asthma visits related to oak, birch, and grass pollen in 2030, and more than 6,000 additional visits in 2050.[65] More than a quarter of these added visits would occur in the Northeast.

MOSQUITO- AND TICK-BORNE INFECTIONS ARE INCREASING

Rising temperatures and changes in rainfall have increased suitable habitat for ticks and mosquitoes and allowed them to be active earlier in the year.[66] That's bad news for the more than 170,370 Pennsylvanians who work outdoors, such as farmers, landscapers, and highway workers.[67] It also affects the millions of Pennsylvania residents who enjoy outdoor activities like visiting parks and picnicking.[68]

Lyme disease, the most common illness transmitted by ticks in the United States, causes flulike symptoms in its early

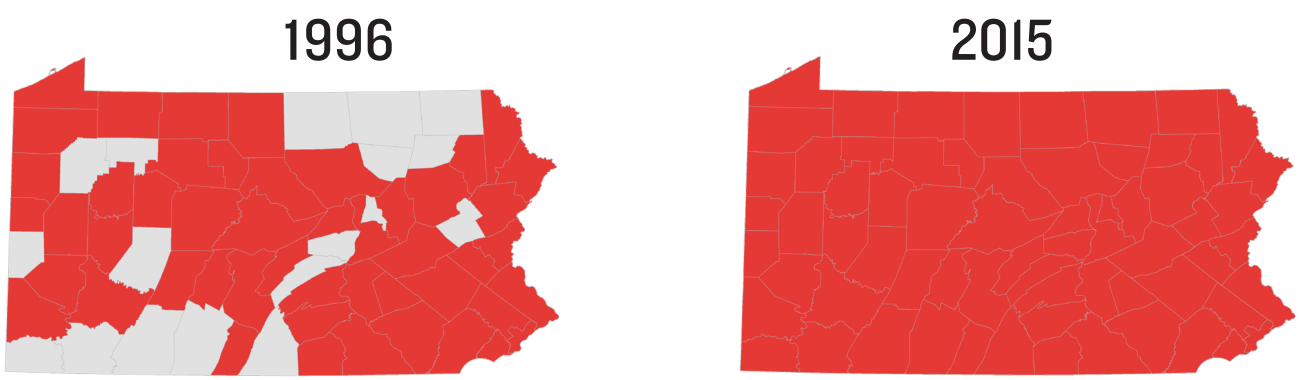

A blacklegged tick on human skin.

stages.[69] Later on—weeks or months after the initial bite of an infected tick—people with untreated Lyme disease can suffer debilitating muscle and joint pain, headaches, memory problems, and even fatal heart damage.[70] Pennsylvania reported 69,376 confirmed or probable cases of Lyme disease from 2008 to 2017 and had the third-highest average rate of confirmed cases in the country from 2015 to 2017.[71] The percentage of childhood cases of Lyme disease requiring hospital admission in Pennsylvania roughly tripled from 2006 to 2015, with a median hospital stay of three days.[72]

Blacklegged ticks, which can carry the bacteria that cause Lyme disease, are expanding to new counties in Pennsylvania. In 1996 these ticks were reported or established in only 49 of Pennsylvania's 67 counties but by 2015 had spread to every county in the state (Figure 2).[73] The spread of ticks may be due to a combination of causes, including increases in tick-friendly habitat because of reforestation, subdivision development in forested areas, local increases in the population of deer and mice that carry ticks, and warmer temperatures caused by climate change.[74]

FIGURE 2. DISTRIBUTION OF BLACKLEGGED TICKS IN PENNSYLVANIA, 1996 AND 2015

Counties in Pennsylvania where blacklegged ticks were reported (fewer than six ticks of a single life stage) or established (six or more ticks, or two life stages) in 1996 and 2015.



BLACKLEGGED TICKS
- Established or reported
- No records

Figure adapted from Eisen et al., *Journal of Medical Entomology* 53 (2016).

Warmer spring weather in Pennsylvania is also expected to jump-start the active period of disease-carrying ticks. If high levels of carbon pollution continue unchecked, the Lyme disease season in Pennsylvania could start 2.8 weeks earlier from 2065 to 2080 than it did from 1992 to 2007.[75]

White Pennsylvanians and those living in wealthier communities actually have higher odds of contracting Lyme disease than low-income people and people of color, judging from electronic health records from 2006 to 2014.[76] This state-level finding is consistent with a national study that found that majority-white counties with higher levels of education and more seasonally vacant housing had a higher incidence of Lyme disease from 2007 to 2013.[77] This may be due to a combination of human behavior (i.e., people with vacation homes spending more time outside) and the presence of more vegetation—and more mice—around homes that aren't occupied year-round.

Rising temperatures are also extending the geographic range and active season of Asian tiger mosquitoes and other carriers of West Nile virus in the United States.[78] West Nile virus causes vomiting and fatigue in about 1 in 5 infected people. About 1 in 150 infected people develop severe and potentially fatal neurological illnesses.[79] In 2001, when the first case of West Nile virus was reported in Pennsylvania, the commonwealth's population of Asian tiger mosquitoes was found mostly near Philadelphia.[80] By 2005 the mosquitoes had spread across much of southern Pennsylvania, and it's possible that by 2050 they will be found in most of the state.[81]

The average annual number of Asian tiger mosquitoes collected at mosquito traps in Pennsylvania has already increased, jumping nearly tenfold between 2001 and 2010.[82] Because of rising temperatures, eight Pennsylvania cities had an average of nearly 13 more days with an increased risk of disease transmission by mosquitoes in 2017 than they did in 1970.[83] From late July to mid-August 2018, heavy rain and flooding created more breeding habitat for infected mosquitoes, putting residents in 47 of Pennsylvania's 67 counties at high risk for exposure to West Nile virus.[84] By the end of 2018, 119 people in Pennsylvania had contracted West Nile virus and 8 people had died, making it the second-worst year on record for the state since 2003.[85]

ACTING ON CLIMATE CAN PROTECT OUR HEALTH

The good news is that cutting back on fossil fuels and switching to clean, renewable energy will help limit the dangerous effects of climate change and protect Pennsylvanians' health.

Progress to Date

Pennsylvania's total carbon dioxide emissions declined by nearly 23 percent from 2005 to 2016, resulting mostly from changes in the state's electric power sector.[86] From 2007 to 2015, Pennsylvania's wind and solar power facilities prevented more than 17 million metric tons of carbon dioxide emissions, equivalent to the emissions from more than 41.4 billion passenger vehicle miles.[87] These renewable power plants also prevented the emission of more than 58,000 metric tons of sulfur dioxide, another dangerous air pollutant, and more than 23,000 metric tons of nitrogen oxides, key building blocks of smog and particle pollution.[88]

While renewable energy has made inroads in Pennsylvania, the largest drop in the state's carbon dioxide emissions has come from the widespread replacement of coal-fired power plants with natural gas–fired plants.[89] Unfortunately, although natural gas emits less climate-changing pollution than coal when it is burned, it still releases a significant amount of carbon dioxide. And during the production of natural gas there are significant emissions of methane, the primary component of natural gas and a climate pollutant that is up to 87 times more potent than carbon dioxide as a climate pollutant over a 20-year timeline.[90] The state's move from coal to natural gas threatens to lock in decades of harmful carbon dioxide and methane pollution.[91]

Next Steps in Reducing Carbon Pollution

In order for Pennsylvania to continue reducing the carbon pollution coming from its power sector, the state should impose progressively stricter limits on emissions, improve energy efficiency, and significantly increase the clean energy goals in the state's Alternative Energy Portfolio Standards Act (AEPS).[92]

Carbon Limits

Pennsylvania is one of only a few states in the Northeast without limits on carbon pollution from its power sector. Three of the state's neighbors—Maryland, Delaware, and New York—belong to the Regional Greenhouse Gas Initiative (RGGI), a multistate collaborative to limit carbon pollution from power plants through a carbon trading program.[93] New Jersey is poised to reenter RGGI after being withdrawn by former Governor Chris Christie in 2011, and Virginia has developed a state carbon limit that will integrate with the RGGI trading market.[94] The RGGI program generated an estimated $5.7 billion in health benefits across the region from 2009 to 2014—including between $817 million and $1.85 billion in Pennsylvania, which is not currently a RGGI state.[95] By joining RGGI with a strong pollution cap, Pennsylvania will further protect the health and environment of RGGI states and their neighbors.

Energy Efficiency

Currently, a great deal of energy is wasted in Pennsylvania's buildings and factories because of inadequate weatherization, inefficient appliances, and other factors.[96] Improving energy efficiency is the most cost-effective way for Pennsylvania to reduce carbon pollution from its power plants and will save customers money. One way the state can continue to improve energy efficiency is by updating Act 129 of 2008, a law that requires the state's largest electric utilities to administer energy efficiency programs for customers.[97] Current programs reduce electricity use by less than 1 percent per year on a statewide basis, which is considerably less than Pennsylvania could achieve if its energy efficiency programs were more robust.[98] Pennsylvania counties and townships can also move to implement Pennsylvania's new Commercial Property Assessed Clean Energy Act (Act 30 of 2018), which is designed to lower the cost of financing for efficiency and clean energy projects.[99]

Renewable Energy

Pennsylvania's AEPS, which was passed in 2004, requires renewable energy to make up only a very small share of the electricity sold by the state's major utilities.[100] Furthermore, the statute actually *requires* utilities to buy a greater share of electricity from dirty power plants (e.g., ones that use waste coal and municipal waste) than from clean ones. As a result, the AEPS has been a relatively weak driver of renewable energy, which today accounts for less than 5 percent of the state's electricity generation.[101] In 2017 the Pennsylvania legislature updated the AEPS to make the in-state solar market more competitive. However, any kind of meaningful solar and wind energy growth will require strengthening the law's overall clean energy targets.[102] According to a 2018 report by the Pennsylvania Department of Environmental Protection, stronger AEPS targets combined with other policies could help Pennsylvania generate 10 percent of its electricity from solar sources alone by 2030.[103]

Transportation

Transportation was Pennsylvania's second-largest source of carbon dioxide emissions after power plants in 2016.[104] Fortunately, recent moves by Pennsylvania policymakers have the potential to address this major source of pollution and deliver significant health and economic benefits.[105] In mid-December 2018, Pennsylvania Governor Tom Wolf, the mayor of Washington, D.C., and eight other Northeast and Mid-Atlantic governors committed to developing a regional clean transportation plan.[106] The Transportation and Climate Initiative is intended to cut carbon pollution, support the development of clean energy jobs and the economy, make the transportation system more disaster resilient, and improve transportation choices for communities across the region.[107] Such a plan could deliver numerous health benefits, including less traffic-related stress, improved response times by paramedics, higher birth weights because of improved air quality, and longer life spans because of decreases in lung disease and increases in physical activity.[108]

While the regional clean transportation plan is under development, Pennsylvania can begin reducing transportation emissions through policies that incentivize and facilitate investments in charging infrastructure for electric cars, trucks, and buses. For example, the General Assembly could enact the Clean Transportation Infrastructure Act, which would direct electric utilities to work with regional stakeholders to develop and execute plans to expand transportation electrification.[109] This law would build on a 2018 pilot program enabling Duquesne Light Company, the electric utility that serves Pittsburgh and some of its suburbs, to invest in more charging stations, educate the public about the benefits of electric vehicles, and improve planning for future upgrades to the electric grid.[110]

NEXT STEPS IN CLIMATE ADAPTATION

Pennsylvania also needs more detailed climate adaptation plans—that is, ways to cope with today's climate change impacts and prepare for future disruption.

Under a 2008 state law, the Pennsylvania Department of Environmental Protection is required to issue updated climate action plans every three years.[111] The health section of the 2018 action plan identifies two broad adaptation strategies: (1) "Improve reliability and accessibility of public information about climate-related health risks"; and (2) "Bolster emergency preparedness and response."[112] However, the steps underlying those strategies (e.g., mapping vulnerable populations and establishing heat advisories) lack critical details about timelines and implementing agencies.[113] In the near term, the Pennsylvania Department of Health should develop a climate vulnerability assessment that combines data on socioeconomic and other health-risk factors with information about the ability of communities, health providers, and key institutions to cope with the health consequences of climate threats. Such an assessment would help the state make evidence-based choices about which climate impacts to prioritize and how best to help the people most vulnerable to those impacts.[114]

The bottom line is that Pennsylvania residents have much to gain from climate action—and lives to lose if we fail to cut our emissions and to build resilience to the damage already being done.

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