

Comments of the Attorneys General of California, Connecticut, Delaware, Illinois, Iowa, Maine, Maryland, Massachusetts, Minnesota (by and through its Minnesota Pollution Control Agency), New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, and the District of Columbia, the Maryland Department of the Environment, and the cities of Boulder, Chicago, Los Angeles, New York, Philadelphia, and South Miami, and Broward County

on

the Environmental Protection Agency's Proposed Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 83 Fed. Reg. 65,424 (Dec. 20, 2018)

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EXECUTIVE SUMMARY

The Attorneys General of California, Connecticut, Delaware, Illinois, Iowa, Maine, Maryland, Massachusetts, Minnesota (by and through its Minnesota Pollution Control Agency), New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, and the District of Columbia, the Maryland Department of the Environment, and the cities of Boulder, Chicago, Los Angeles, New York, Philadelphia, and South Miami, and the county of Broward (together, “States and Cities”) submit these comments in opposition to the Environmental Protection Agency’s (EPA) proposed Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 83 Fed. Reg. 65,424 (proposed Dec. 20, 2018) (Proposed Rule). EPA intends that the Proposed Rule will replace the currently effective carbon dioxide (CO₂) standards of performance (Current Standard), 80 Fed. Reg. 64,510 (Oct. 23, 2015), which established the first nationwide emission limits new, modified, and reconstructed fossil fuel-fired electric generating power plants.

The States and Cities urge EPA to withdraw the Proposed Rule and leave the Current Standard in place. EPA promulgated the Current Standard in 2015 after considering an extensive factual record and explaining and supporting its legal justifications for its action. For new coal-fired power plants, the CO₂ emission limit in the Current Standard is based on what a modern plant could achieve by capturing a portion of its CO₂ emissions and storing it underground. EPA found that this partial carbon capture and sequestration (partial CCS) was the best system of emission reduction under Clean Air Act section 111 based on EPA’s analysis of its technical feasibility and cost and the availability of geological storage sites throughout the country. The Current Standard is a rational, legal, and necessary response to the increasing harms from CO₂ pollution.

In contrast to its thoroughly supported 2015 rulemaking, EPA bases its new Proposed Rule on vague generalizations, illogical conclusions, unwarranted (and often even unacknowledged) changes in position, and distortions of the factual record. In its haste to roll back prudent CO₂ emission limits that exist under current law, EPA disregards, without reasonable explanation, the contrary and inconvenient findings it made just three years ago. The Supreme Court has identified this type of behavior as a hallmark of arbitrary and capricious rulemaking. Further, replacing the Current Standard with the weaker Proposed Rule is contrary to the requirements and purpose of the Clean Air Act.

EPA bases its reversal of its 2015 findings entirely on two new assertions. First, it says that partial CCS is more expensive than it previously believed. Second, it says that partial CCS is not available over as wide an area of the country as it previously believed. EPA’s analysis of both of these issues is flawed and not nearly sufficient to overcome the contrary factual record EPA established in 2015. In reality, in the past three years the evidence that partial CCS is a reasonable and effective CO₂ control strategy has only grown. In addition, the majority of states have shown through their statutes and regulations that CCS is a demonstrated system of emissions reduction and/or that CCS adds value to businesses.

For its revised cost calculation, EPA improperly inflates the cost of partial CCS to make it appear harder to implement. The agency fails to explain why each of the components of its

new calculation are superior to its previous multifaceted economic analysis. And, none of EPA's new cost calculations is sufficient to support EPA's conclusion that the cost of partial CCS is so great under the legal test for reasonableness that it can no longer be considered the best system of emission reduction. EPA's new cursory economic analysis avoids even calculating what impact the Proposed Rule will have if a new coal-fired power plant were to be built, even as it admits that CO₂ emissions would increase.

EPA's new discussion of the geographical availability of partial CCS is remarkable for its lack of analysis, disregard of facts, and leaps of logic. EPA previously found that more than enough potential underground storage capacity existed to store as much CO₂ as needed by any coal-fired plants and that pipelines would provide sufficient access to those sites from around the country. Nevertheless, EPA now feels that geological storage is not sufficiently available, ostensibly based on two new conclusions: (a) A type of geologic formation that EPA did not rely on in 2015 and that accounts for a tiny fraction of potential storage capacity must be disregarded; and (b) some areas of the country do not get as much rainfall as others so it might be harder to operate a CCS system in some places. EPA fails to provide evidence that either of these factors would support EPA reversing its well-considered determination in 2015 that partial CCS was sufficiently available across the nation that it should be considered the best system of emission reduction.

Research since EPA issued the Current Standard in 2015 has added to the overwhelming scientific evidence that greenhouse gas emissions are an immediate and escalating threat to well-being of people, the economy, and the environment, both in the United States and around the world. The States and Cities are already experiencing the severe effects of climate change, and further delay in reducing these risks would be inexcusable. EPA should put its efforts into protecting the public from the harms of greenhouse gas emissions and leave the Current Standard in place, instead of increasing the risk to public health and the environment by rolling back reasonable controls on dangerous pollutants, which is exactly what EPA seeks to do in the Proposed Rule.

I. INTRODUCTION

A. Recent evidence of climate change

Since EPA's publication of the original new source performance standard in 2015, the Earth experienced the warmest year on record—2016—breaking records set previously in 2014 and 2015.¹ Collectively, the past five years, from 2014 to 2018, are the warmest years in the modern record.² Climate science over these five years bolstered what has long been the

¹ *Global Temperature*, National Aeronautics and Space Administration, <https://climate.nasa.gov/vital-signs/global-temperature/> (last visited Mar. 14, 2019).

² Press Release, National Aeronautics and Space Administration, 2018 fourth warmest year in continued warming trend, according to NASA, NOAA (Feb. 6, 2019), <https://climate.nasa.gov/news/2841/2018-fourth-warmest-year-in-continued-warming-trend-according-to-nasa-noaa/>. Global temperatures during 2018's first half were the hottest on record during a La Niña year. Press Release, World Meteorological Organization, July sees extreme

conclusive consensus: Earth's climate system is rapidly changing, primarily due to human activity, and demands an ambitious, all-hands reduction of greenhouse gas emissions in order to avert the gravest impacts to American economies, ecosystems, and lives.

In 2017 and 2018, the U.S. Global Change Research Program released the Fourth National Climate Assessment (Fourth Assessment) in two volumes, which together review the current state of climate change science and detail ongoing and projected future physical impacts of global warming.³ Coordinated by lead authors across 13 federal agencies, including EPA, the Fourth Assessment represents the work of over 300 governmental and non-governmental experts. It was externally peer-reviewed by a committee of the National Academy of Sciences, Engineering, and Medicine and underwent several rounds of technical and policy review by their member agencies.⁴ In short, it is the federal government's authoritative analysis of climate science and the impacts of climate change on the United States. One key conclusion is stark, but hopeful: by shifting from our current high-emissions scenario to a low-emissions scenario, "[b]y the end of this century, thousands of American lives could be saved and hundreds of billions of dollars in health-related economic benefits gained each year."⁵ Future generations would benefit even more.

The Earth's climate is rapidly changing. Earth's atmosphere now contains a higher concentration of CO₂ than it has in the past three million years.⁶ In 2017, that concentration was 400 parts per million (ppm); in 2018, atmospheric CO₂ levels exceeded 410 ppm for the first time, then reached 411 ppm in May 2018. The growth rate of the global CO₂ level is accelerating: in the 1980s, it averaged 1.6 ppm per year and in the 1990s, 1.5 ppm per year, but

weather with high impacts (Aug. 1, 2018), <https://public.wmo.int/en/media/news/july-sees-extreme-weather-high-impacts>.

³ U.S. Global Change Research Program, Climate Science Special Report: Fourth National Climate Assessment, Volume I (D.J. Wuebbles, et al., eds., 2017), <https://science2017.globalchange.gov/> (Fourth Assessment, Vol. I); U.S. Global Change Research Program, Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, (D.R. Reidmiller et al. eds., 2018), <https://nca2018.globalchange.gov/> (Fourth Assessment, Vol. II); *see generally* Global Change Research Act of 1990, Pub. L. No. 101-606. Both Volumes I and II of the Fourth Assessment are available in the rulemaking docket for the Clean Power Plan replacement. *See, e.g.*, Docket Nos. EPA-HQ-OAR-2017-0355-24806; EPA-HQ-OAR-2017-0355-26637. Note that EPA has incorporated into the rulemaking docket for the Proposed Rule all documents in the rulemaking docket for the Clean Power Plan replacement. *See* U.S. EPA, Memorandum, Incorporation by Reference of Docket No. EPA-HQ-OAR-2017-0355 (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11938.

⁴ U.S. Global Change Research Program, Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief, 1-2 (D.R. Reidmiller et al. eds., 2018), https://nca2018.globalchange.gov/downloads/NCA4_Report-in-Brief.pdf (Fourth Assessment, Vol. II: Report-in-Brief).

⁵ Fourth Assessment, Vol. II: Report-in-Brief, at 102.

⁶ Fourth Assessment, Vol. I, at 31.

increased to 2.2 ppm per year during the last decade. Historically high levels of coal, oil, and natural gas consumption are fueling these escalating CO₂ growth rates.⁷

High atmospheric CO₂ concentrations have, in turn, driven historically high global temperatures. Global annual average surface air temperature increased by 1.8°F (1.0°C) from 1901 to 2016, the Fourth Assessment concluded. “This period is now the warmest in the history of modern civilization.”⁸ Melting ice sheets and glaciers, caused by the increases in temperatures, have accelerated global mean sea level rise faster during the last century than in any previous century in at least 2,800 years, contributing to daily tidal flooding increases in over 25 Atlantic and Gulf Coast cities.⁹ Reduced snow cover threatens regional water supplies,¹⁰ while ocean acidification endangers marine aquaculture and major ecosystems.¹¹ In fact, researchers project oceans will become more acidic than they have been in the last 14 million years due to the amount of atmospheric CO₂ they have absorbed to date.¹²

The science behind attribution of extreme storms to anthropogenic climate change continues to improve, and climate models generally show the planet’s warming produces more frequent intense hurricanes.¹³ Future hurricanes will have stronger maximum winds, move more slowly, and drop more precipitation, according to a modeling analysis of 22 recent hurricanes by U.S. government scientists.¹⁴ Similarly, in 2018, U.S. government and academic scientists found warmer sea surface temperatures and available atmospheric moisture, attributable to climate

⁷ National Oceanic and Atmospheric Administration, “Another Climate Milestone on Mauna Loa” (Jun. 7, 2018), <https://research.noaa.gov/article/ArtMID/587/ArticleID/2362/Another-climate-milestone-falls-at-NOAA%E2%80%99s-Mauna-Loa-observatory>

⁸ Fourth Assessment, Vol. I, at 10, 13, 17 (Exec. Summ.), 39, 40 (Ch. 1), 78, 80-84 (Ch. 2).

⁹ *Id.* at 10, 25-27 (Exec. Summ.), 51-52 (Ch. 1).

¹⁰ *Id.* at 10 (Exec. Summ.), 239-240 (Ch. 8).

¹¹ *Id.* at 28 (Exec. Summ.), 371-374 (Ch. 13).

¹² S. M. Sosdian, et al., “Constraining the evolution of Neogene ocean carbonate chemistry using the boron isotope pH proxy,” in *Earth and Planetary Science Letters*, Vol. 498, 362-376 (Sept. 2018), <https://doi.org/10.1016/j.epsl.2018.06.017>.

¹³ Fourth Assessment, Vol. I, at 258-260 (Ch. 9).

¹⁴ Gutmann et al., “Changes in Hurricanes from a 13-Yr Convection-Permitting Pseudo-Global Warming Simulation, in *J. Climate*, Vol. 31, 3643-3657 (May 2018), <https://doi.org/10.1175/JCLI-D-17-0391.1>. The unprecedented rainfall totals associated Hurricane Harvey’s stall of over Texas in 2017 provides a notable example of how slow-moving hurricanes impact regional rainfall amounts. Kossin, J., “A global slowdown of tropical-cyclone translation speed,” in *Nature*, 558, 104-107 (June 2018), <https://doi.org/10.1038/s41586-018-0158-3>.

change, were expected to increase Hurricane Florence's rainfall amounts by over 50 percent.¹⁵ On October 10, 2018, Hurricane Michael made landfall near Mexico Beach, Florida, as the strongest storm ever to hit the Florida Panhandle, and the fourth-strongest ever to landfall in the continental United States. As Hurricane Michael approached the United States, abnormally warm waters in the Gulf of Mexico fueled its rapid intensification.¹⁶ These intensifications are consistent with scientists' prediction for increasing hurricane magnitudes in a warming world.

Human activities, especially greenhouse gas emissions, are primarily responsible for global climate change. The Fourth Assessment confirmed the established science that human-caused greenhouse gas emissions are primarily responsible for the 1.8°F of observed warming from 1901 to 2016, concluding: "observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause."¹⁷

Since 2015, the National Academies of Sciences, Engineering, and Medicine have determined that scientists' ability to attribute individual extreme weather events to climate change is increasing.¹⁸ This likelihood is "greatest for those extreme events that are related to an aspect of temperature, such as the observed long-term warming of the regional or global climate, where there is little doubt that human activities have caused an observed change."¹⁹

The journal of the American Meteorological Society (AMS) has published seven annual special reports describing studies evaluating the connection (or lack of connection) between specific extreme weather events and anthropogenic climate change. In 2018, for the second year in a row, scientists were able to identify extreme weather events that could not have happened without warming of the climate through human-induced climate change. In previous AMS reports, 89 studies of extreme weather events found that climate change had increased the

¹⁵ Reed et al., "The Human Influence on Hurricane Florence" (2018), <https://crd.lbl.gov/assets/Uploads/Wehner/climate-change-Florence-0911201800Z-final.pdf>. The study is based on forecasts before Florence came ashore.

¹⁶ National Weather Service, National Hurricane Center, Hurricane Michael Discussion Number 10 (Oct. 20, 2018), <https://www.nhc.noaa.gov/archive/2018/al14/al142018.discus.010.shtml>; <https://phys.org/news/2018-10-turbocharged-michael-percent-stronger-day.html>

¹⁷ Fourth Assessment, Vol. II, at 73 (Ch. 2). *See also* Fourth Assessment, Vol. I, at 36 ("Over the last century, there are no alternative explanations supported by the evidence that are either credible or that can contribute more than marginally to the observed patterns.").

¹⁸ National Academies of Sciences, Engineering, and Medicine, *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, DC: The National Academies Press (2016). <https://doi.org/10.17226/21852>

¹⁹ *Id.* at 7, 128.

likelihood of the event occurring.²⁰ However, in the 2017 AMS report, the authors found several 2016 extreme weather events that would not have been “possible without the influence of human caused climate change.”²¹ These extreme events included: (1) record-breaking global temperatures, (2) record-breaking regional temperatures over the Asian continent, and (3) the anomalous warm water temperatures in Alaska’s Bering Sea. In the 2018 AMS report, the November 2017/18 Saman Sea marine heatwave was found to be virtually impossible without anthropogenic influence.²² These events are beyond the bound of the “natural” climate and *would not have occurred* absent the ongoing anthropogenic alteration of Earth’s climate.

Further confirming the attribution of extreme events to climate change, two independent research teams, including one from the Department of Energy’s Lawrence Berkeley National Laboratory, recently released studies identifying a clear anthropogenic contribution to the torrential precipitation that inundated Houston during Hurricane Harvey, reporting the precipitation was 15 to 19 percent more intense due to climate change.²³ It is estimated that Hurricane Harvey was the second costliest natural disaster on record in U.S. history, resulting in \$125 billion in total damages.²⁴ Similar studies indicate the intensity and frequency of such events have increased since 1901, especially in the northeastern United States.²⁵ For instance, in

²⁰ Herring, S. C., Eds., “Explaining Extreme Events of 2016 from a Climate Perspective,” in *Bull. Amer. Meteor. Soc.*, Vol. 98 (No. 12), p. S1 (Dec. 2017), https://extranet.gfdl.noaa.gov/~atw/yr/2018/2016_bams_eee_high_res.pdf.

²¹ *Id.*

²² Herring, S.C., N. Christidis, A. Hoell, M.P. Hoerling and Stott, P.A., eds., “Explaining Extreme Events of 2017 from a Climate Perspective,” *Bull. Amer. Meteor. Soc.*, Vol. 100 (No. 1), p. S1-S117, <https://journals.ametsoc.org/doi/abs/10.1175/BAMS-ExplainingExtremeEvents2017.1>.

²³ Risser M. and M.F. Wehner, “Attributable human-induced changes in the likelihood and magnitude of the observed extreme precipitation during Hurricane Harvey,” in *Geophys. Res. Ltrs., Lett.*, 44 (Dec. 2017), <http://dx.doi.org/10.1002/2017GL075888>; Geert Jan van Oldenborgh et al., “Attribution of extreme rainfall from Hurricane Harvey, August 2017, in *Environ. Res. Ltrs.*, Vol. 12, 124009, 1, 9 (Dec. 2017), <https://iopscience.iop.org/article/10.1088/1748-9326/aa9ef2>.

²⁴ *Hurricane Costs*, National Oceanic and Atmospheric Administration, Office for Coastal Management, <https://coast.noaa.gov/states/fast-facts/hurricane-costs.html> (last visited Mar. 14, 2019).

²⁵ Fourth Assessment, Vol. I, at 20 (Exec. Summ.), 210-213, 214-216 (Ch. 7). For example, one study concluded anthropogenic forcing has increased the odds of an extreme, three-day rainfall event (like the Louisiana flooding in August 2016) by 40% or more. (*Id.* at 216 (citing van der Wiel, K., *et al.*, “Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change,” in *Hydrology & Earth Sys. Sciences*, Vol. 21, 897-921 (2017) <http://dx.doi.org/10.5194/hess-21-897-2017>).)

New York State, communities and infrastructure have incurred significant damage from heavy rains in recent years.²⁶

Reducing greenhouse gas emissions will avert the gravest impacts to economies, ecosystems, and lives. Climate change projections developed by the Intergovernmental Panel on Climate Change (IPCC) explore multiple paths of various greenhouse-gas emissions levels. Consistently, projections based on lower emissions levels show less harm to ecosystems and human health, economies, agriculture, and infrastructure, than do high-emission scenarios. Relying on the IPCC standards, EPA and other federal agencies conclude in the Fourth Assessment that by 2100 “thousands of American lives could be saved and hundreds of billions of dollars in health-related economic benefits gained each year under a pathway of lower greenhouse gas emissions.”²⁷

Research since EPA’s 2015 rulemaking confirms the enormous relative benefits of a low-emissions scenario. The Fourth Assessment’s first volume (2017) projected that, under relatively low-emissions scenarios, global temperatures would increase by 0.5° to 1.3°F by the end of the century, and under high-emissions scenarios, by 4.7° to 8.6°F.²⁸ However, temperature changes are expected to be higher for the contiguous United States. Increases of 2.5°F are projected between 2021 and 2050 relative to the average from 1976 to 2005 in all Representative Concentration Pathway emission scenarios, but much larger rises are projected by the end of this century, as high as 5.8° to 11.9°F for the highest emission scenario.²⁹ According to the IPCC’s October 2018 report, global warming is likely to reach 1.5°C between 2030 and 2052 if emissions continue to increase at the current rate.³⁰

The difference in global temperature rises under lower- or higher-emissions scenarios translates to billions of dollars in human costs and incalculable damage to the environment. National climate response costs reached \$306 billion in 2017, the most expensive year on record.³¹ If emissions continue to grow at historic rates, the Fourth Assessment finds “annual

²⁶ Current & Future Trends in Extreme Rainfall Across New York State, A Report from the Environmental Protection Bureau of the New York State Attorney General (Sept. 2014) https://ag.ny.gov/sites/default/files/extreme_precipitation_report9214b.pdf.

²⁷ Fourth Assessment, Vol. II: Report-in-Brief, at 102.

²⁸ Fourth Assessment, Vol. I, at 133 (Ch. 4).

²⁹ *Id.* at 185 (Ch. 6).

³⁰ Intergovernmental Panel on Climate Change, Masson-Delmotte, V., et al., Eds., “Global warming of 1.5 °C - Summary for Policymakers,” at 6 (Oct. 6, 2018), http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf (IPCC 2018 Summary).

³¹ National Oceanic and Atmospheric Administration, Assessing the U.S. Climate in 2017 (December 2017), <https://www.ncei.noaa.gov/news/national-climate-201712>. The following year, 2018, marked the eighth consecutive year with eight or more billion-dollar climate disasters, including Hurricane Michael (\$25 billion), Hurricane Florence (\$24 billion), and the complex of western wildfires (\$24 billion). National Oceanic and Atmospheric Administration,

losses in some economic sectors are projected to reach hundreds of billions of dollars by the end of the century—more than the current gross domestic product of many U.S. states.”³² A study of agricultural crop response to climate change indicates that, while insect pests currently consume 5 to 20 percent of major grain crops (such as wheat, rice, and corn), models show yield lost to insects will increase by 10 to 25 percent per degree Celsius of warming.³³ The IPCC projects major damage to marine ecosystems such as coral reefs, which are projected to decline 70 to 90 percent at 1.5°C of warming, while effectively disappearing worldwide at 2°C warming.³⁴ Under current emissions levels, self-reinforcing climate system feedbacks, including the die-off of boreal forests, Arctic sea ice loss, and the release of methane from permafrost, risk creating a “Hothouse Earth” effect, where warming continues even if greenhouse gas emissions are eventually reduced. Some of these feedbacks may not be reversible, even over the long term.³⁵

Limiting climate change to the lower-emissions scenarios is an urgent task that demands a strong government commitment to emissions reductions.³⁶ Likewise, it is imperative the United States exercise its technology-forcing powers to advance proven and viable emissions-reducing science—such as geologic carbon capture and storage—into more effective, widespread uses.

B. Climate-change-related harms affecting States and Cities

The States and Cities are home to approximately 158 million people, or roughly 48 percent of the population of the United States. We are already suffering the deleterious impacts of global climate change caused by manmade emissions of greenhouse gases. Our residents have lost property, been displaced from homes, and even been killed as a result of severe weather events exacerbated by climate change. Our infrastructure has been damaged and our economies have been injured by more extreme heat, shorter winters, and rising sea levels. The recent Fourth Assessment projects more extreme-weather impacts for every region of the U.S.—including major damage to agriculture, coastal industries, utility grids, transportation networks, air quality, and human health—from coastal flooding, heat waves, drought, and wildfires, as well as from the spread of tree-killing and disease-carrying pests.

Appendix A to these comments contains a detailed description, with citations, of significant harms and threats each of the States and Cities is facing. Those threats are highlighted in this section.

Assessing the U.S. Climate in 2018 (Dec. 2018), <https://www.ncei.noaa.gov/news/national-climate-201812>.

³² Fourth Assessment, Vol. II, at 26 (Summary Findings).

³³ Deutsch, C. et al., “Increase in crop losses to insect pests in a warming climate,” in *Science*, 31 August 2018: 916-919, <https://doi.org/10.1126/science.aat3466>.

³⁴ IPCC 2018 Summary at 10.

³⁵ Steffen, W., et al., “Trajectories of the Earth System in the Anthropocene,” in *Proceedings of the Nat’l Academy of Sciences*, Aug. 14, 2018 115 (33) 8252-8259, <https://doi.org/10.1073/pnas.1810141115>.

³⁶ IPCC 2018 Summary at 17-18.

- **Heat waves.** Over the past fifty years, record-setting temperatures and intense heat waves have spiked in most regions of the U.S.³⁷ If emissions continue at their present high rate, the increase in extreme heat events is projected by 2090 to cause 2,000 additional premature deaths per year in the Midwest, and 1,300 per year in the Northeast.³⁸ Between the middle and end of this century Chicago could experience five days per year (low-emissions scenarios) or twenty-five days per year (high-emissions scenarios) with conditions similar to the 1995 heat wave that caused 800 deaths in the city.³⁹ Parts of the Southeast will face more than 100 additional warm nights (greater than 75°F) per year, leading to more heat-related illnesses and deaths.⁴⁰ In Washington, D.C., heat emergency days (when the heat index exceeds 95°F) could more than double, from the current 30 days per year to 70 days per year (low-emissions scenario) or 105 days per year (high-emissions scenario) by the 2080s.⁴¹
- **Wildfires.** The number of large forest fires has significantly increased over the past three decades, with one model finding human-driven climate change responsible for doubling the area burned by forest fires over 1984-2015.⁴² The Northwest's exceptionally warm 2015 led to its worst wildfire season in recorded history, with 1.6 million acres burned.⁴³ According to California's Fourth Climate Assessment (August 2018), "large wildfires (greater than 25,000 acres) could become 50% more frequent by end of century if emissions are not reduced."⁴⁴ More years will see extremely high areas burned, even compared to the historically destructive wildfires

³⁷ Fourth Assessment, Vol. I, at 191-92 (Ch. 6). In the Southeast, 61% of major cities are currently exhibiting worsening heat waves (in timing, frequency, intensity, or duration). *Fourth Assessment, Vol. II*, at 752 (Ch. 19).

³⁸ Fourth Assessment, Vol. II, at 698 (Ch. 18), 898 (Ch. 21).

³⁹ Hayhoe, K., et al., "Climate change, heat waves, and mortality projections for Chicago," in *J. of Great Lakes Res.*, Vol. 36, Supp. 2, 65-73 (2010), <https://doi.org/10.1016/j.jglr.2009.12.009>.

⁴⁰ Fourth Assessment, Vol. II, at 752-753 (Ch. 19).

⁴¹ District of Columbia Department of Energy & Environment, *Climate Projections & Scenario Development*, at 27 (June 2015), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/150828_AREA_Research_Report_Small.pdf.

⁴² Fourth Assessment, Vol. I, at 242-243 (Ch. 8).

⁴³ Fourth Assessment, Vol. II, at 1066-67 (Ch. 24).

⁴⁴ Thorne, James H., et al., California's Fourth Climate Change Assessment, California Natural Resources Agency, 9 (Aug. 2018), www.ClimateAssessment.ca.gov. California's Fourth Climate Change Assessment includes 33 papers from State-funded researchers and 11 papers from externally-funded researchers, as well as regional summaries and a statewide summary of climate vulnerabilities, and a key findings paper. The Statewide Summary Report (Calif. 4th Assessment) can also be found at Docket ID EPA-HQ-OAR-2017-0355-24806, Ex. 12.

of 2017 and 2018; by 2099, California wildfires could burn up to 178 percent more acres per year than current averages.⁴⁵

- **Severe storms.** The past three years have witnessed storms of record destructive power in the Southeast. In 2016, Hurricane Matthew caused \$1.5 billion in damage.⁴⁶ In 2017, warm waters strengthened Hurricane Irma into a devastating high-intensity storm that caused flooding, mass evacuations, and \$50 billion in damage.⁴⁷ In 2018, Hurricane Florence claimed 44 lives in North Carolina and caused an estimated \$17 billion in damage.⁴⁸ Compared to U.S. storms of the last 70 years, Florence produced the second highest amount of rain in a concentrated land area, with four of the top seven storms having occurred in the last three years.⁴⁹ These back-to-back hurricanes, which would have once been described as extremely rare in North Carolina,⁵⁰ are projected to increase in frequency, power, and duration if greenhouse gas emissions continue to drive global warming.⁵¹
- **Flooding.** Coastal flooding, exacerbated by sea-level rise, increasingly plagues the States and Cities. Ordinary rain events now cause flooding in Norfolk, Virginia; Naval Station Norfolk, the world's largest navy base, currently is "one of the most

⁴⁵ Calif. 4th Assessment, at 30.

⁴⁶ Press Release, Federal Emergency Management Agency, Six Months Following Hurricane Matthew, Volunteers Work for North Carolina Progress (Apr. 6, 2017), <https://www.fema.gov/news-release/2017/04/06/six-months-following-hurricane-matthew-government-partners-volunteers-work>.

⁴⁷ Fourth Assessment, Vol. II, at 766-768 (Ch. 19).

⁴⁸ Press Release, North Carolina Governor's Office, Six Months After Florence Made Landfall, North Carolina Continues Work to Rebuild (Mar. 12, 2019), <https://governor.nc.gov/news/six-months-after-florence-made-landfall-north-carolina-continues-work-rebuild>; Press Release, North Carolina Governor's Office, Updated Estimates Show \$17 Billion in Damage (Oct. 31, 2018), <https://governor.nc.gov/news/updated-estimates-show-florence-caused-17-billion-damage>.

⁴⁹ Borenstein, S., Florence Is Nation's Second Wettest Storm, Behind Harvey, WFTV (Sep. 27, 2018), <https://www.wftv.com/weather/eye-on-the-tropics/florence-is-nation-s-second-wettest-storm-behind-harvey/842701535>.

⁵⁰ Based on pre-climate change weather patterns, Hurricane Florence's rainfall was described as an event eastern North Carolina could expect to occur only once every 1000 years. (Risk Management Solutions, "Hurricane Florence: Rainfall up to a 1,000-Year Return Period" (Sep. 14, 2018), <https://www.rms.com/blog/2018/09/14/hurricane-florence-rainfall-up-to-a-1000-year-return-period/>.) Hurricane Matthew would ordinarily be a "500-year flood event." (Office of Water Prediction, National Weather Service, "Hurricane Matthew, 6-10 October 2016 Annual Exceedance Probabilities (AEPs) for the Worst Case 24-Hour Rainfall" (Oct. 18, 2016), http://www.nws.noaa.gov/ohd/hdsc/aep_storm_analysis/AEP_HurricaneMatthew_October2016.pdf.) Yet these storms hit eastern North Carolina *two years* apart.

⁵¹ Fourth Assessment, Vol. I, at 258-260 (Ch. 9).

vulnerable to flooding” military installations in the U.S., as relative sea-level rise contributes to “more frequent nuisance flooding and increased vulnerability to coastal storms.”⁵² In South Florida, tidal flooding has become increasingly frequent and dramatic, and may become a daily, year-round hazard by the 2070s under high- and intermediate- emissions scenarios.⁵³ In Delaware, over 2,000 businesses and 17,000 homes are at risk of permanent inundation from sea-level rise by the end of the century.⁵⁴ In Maryland, catastrophic rainfall and flooding in May 2018 saw the Patapsco River rise nearly 18 feet in just two hours, while flash floods turned Ellicott City’s Main Street into a river over 10 feet deep. These floods will only increase as warming ocean temperatures push sea levels higher. In New England, regional sea-level rise as high as 11 feet is projected.⁵⁵ In the Southeast, sea-level rise and extreme rainfall are projected to cause “daily high tide flooding by the end of the century” and cost up to \$99 billion annually under a high-emissions scenario.⁵⁶

- **Diseases and pests.** In New England, warmer temperatures contribute to the spread of tick-borne diseases like Lyme disease.⁵⁷ In Pennsylvania, climate change is expected to increase the prevalence of West Nile disease in higher-elevation areas and the duration of the transmission season.⁵⁸ Climate change is likewise projected to increase insect-borne disease like dengue fever and Zika virus across the Southeast, including year-round transmission in southern Florida.⁵⁹ In the Southwest, climate change has contributed to increased forest pest infestations, a major cause of tree death. Bark beetle infestations killed 7 percent of western forest area from 1979 to 2012, driven by warming winters and drought.⁶⁰

⁵² U.S. Dept. of Defense, Report on Effects of a Changing Climate to the Department of Defense” (Jan. 2019), <https://www.documentcloud.org/documents/5689153-DoD-Final-Climate-Report.html>.

⁵³ Sweet, W. et al., “Patterns & Projections of High Tide Flooding along the U.S. Coastline Using a Common Impact Threshold,” NOAA Tech. Rep. NOS CO-OPS 086, 15, 23-25 (Feb. 2018), https://tidesandcurrents.noaa.gov/publications/techrpt86_PaP_of_HTFlooding.pdf.

⁵⁴ Del. Dept. of Nat. Res., *Preparing for Tomorrow’s High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware*, 72-75, 78-81 (July 2012), <http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentForWeb.pdf>.

⁵⁵ Fourth Assessment, Vol. II, at 692-695 (Ch. 18).

⁵⁶ *Id.* at 757-758 (Ch. 19).

⁵⁷ Domic, I. & Severnini, E., “‘Ticking Bomb’: The Impact of Climate Change on the Incidence of Lyme Disease,” in *Can. J. of Inf. Dis. & Med. Microbio.*, Vol. 2018, 5719081 (Oct. 2018), <https://doi.org/10.1155/2018/5719081>.

⁵⁸ Shortle, J., et al., Pennsylvania Climate Impacts Assessment Update, 135 (May 2015), <https://www.pennfuture.org/Files/Admin/Pennsylvania-Climate-Impacts-Assessment-Update---2700-BK-DEP4494.compressed.pdf>.

⁵⁹ Fourth Assessment, Vol. II, at 754-55 (Ch. 19).

⁶⁰ *Id.* at 1116-17 (Ch. 25).

- ***Droughts.*** Chronic, long-duration droughts are increasingly likely under high-emissions scenarios.⁶¹ The 2011-2016 California drought, exacerbated by extreme warmth and reduced Sierra Nevada snowpack,⁶² led to losses of over 10,000 jobs and the fallowing of 540,000 acres, at a cost of \$900 million in gross crop revenue in 2015.⁶³ In the Northwest, 2015's record high temperatures led to a "snow drought," in which low snowpack and a dry spring created shortages in irrigation, hydropower, and human consumption and caused widespread fish die-offs. Under high-emissions scenarios, the Northwest's warming winters are projected to cause more precipitation to fall as rain instead of snow, leading to flooding and landslides in the winter and reduced streamflows in spring and summer.⁶⁴ Climate change is similarly projected to increase extremes of rain and drought across the Southeast.⁶⁵
- ***Threats to water quantity and quality.*** Climate change increasingly threatens states that rely on snowpack for their drinking water. Snowpack in Washington's Cascade Mountains has already decreased by 25 percent since the mid-20th century, and is anticipated to decrease by 38 to 46 percent (relative to 1916-2006) by the 2040s.⁶⁶ New Mexico and California face similar reduced snowpack to support their cities, agriculture, and ecosystems.^{67, 68} In Broward County, Florida, rising seas are driving saltwater contamination into freshwater supplies. U.S. Geologic Survey modeling in collaboration with the County reveals a predicted loss of 35 million gallons per day in water supply capacity by 2060 (40 percent of Broward's coastal well field capacity), due entirely to additional sea level rise.
- ***Threats to air quality.*** Currently, more than 100 million U.S. residents live in communities where air pollution exceeds health-based air quality standards. Climate change is projected to increase ground-level ozone and other air pollution, especially

⁶¹ Fourth Assessment, Vol. I, at 240 (Ch. 8); Calif. 4th Assessment, at 22, 24-26.

⁶² Calif. 4th Assessment, at 13.

⁶³ Fourth Assessment, Vol. II, at 1127 (Ch. 25).

⁶⁴ *Id.* at 1054-55, 1066-67 (Ch. 24).

⁶⁵ *Id.* at 775 (Ch. 19).

⁶⁶ State of Knowledge Report, Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers, at 2-5, 6-10 (Dec. 2013), Climate Impacts Group, Univ. of Washington (Wash. State of Knowledge Report), <https://cig.uw.edu/resources/special-reports/wa-sok/>.

⁶⁷ Brian H. Hurd & Julie Coonrod, Climate Change and Its Implications for New Mexico's Water Resources and Economic Opportunities, NM State University, Technical Report 45, at 1, 24 (2008); <https://aces.nmsu.edu/pubs/research/economics/TR45.pdf>.

⁶⁸ Calif. 4th Assessment, at 27.

in already polluted areas.^{69,70} For example, in the Midwest, increased ground-level ozone concentrations are projected to result in an additional 200 to 550 premature deaths per year by 2050, while lengthening pollen seasons will adversely impact children with asthma and respiratory diseases.⁷¹ In the Northwest and Southwest, ozone and wildfire smoke are projected to increase cardiovascular and respiratory diseases.⁷²

- **Threats to utility and transportation networks.** The U.S. has over 60,000 miles of roads and bridges in coastal floodplains, all of which are vulnerable to increasing extreme storms and sea-level rise. On the East Coast alone, flooding has increased transportation disruptions by 85 percent from 2010, to 100 million vehicle-hours of delay.⁷³ Under a high-emissions scenario, EPA itself projects \$400 million more in annual service costs for Midwestern bridges and \$3.3 billion in annual damages to roads by 2050.⁷⁴
- **Threats to agriculture and timber.** In the Midwest, increases in warm-season humidity and precipitation “have eroded soils, created favorable conditions for pests and pathogens, and degraded the quality of stored grain.”⁷⁵ Illinois faces up to 77-percent average yield loss across all crops by the end of the century, while in Iowa, absent significant adaptation, the state could suffer 18- to 77-percent declines in its corn crop, a \$10 billion industry.⁷⁶ In Washington, under a moderate emissions scenario, the range for Douglas fir—a major timber tree—is expected to decline 32 percent by the 2060s.⁷⁷

⁶⁹ Fourth Assessment, Vol. II, at 519 (Ch. 13).

⁷⁰ Climate change likewise weakens the circulating effect of extratropical cyclones that move smog, storms, and heat waves out of cities, thereby exacerbating their damage and health impact. See Gertler, C. et al., “Changing available energy for extratropical cyclones and associated convection in Northern Hemisphere summer,” in *Proceedings of the Nat’l Academy of Sciences* (Feb. 19, 2019) <https://doi.org/10.1073/pnas.1812312116>; Roston, E., “A Summer of Storms and Smog Is Coming,” *Bloomberg* (Feb. 19, 2019), <https://www.bloomberg.com/news/articles/2019-02-19/summer-2019-climate-change-will-bring-strong-storms-and-smog>.

⁷¹ Fourth Assessment, Vol. II, at 896 (Ch. 21); see also *id.* at 1059 (Ch. 24, Northwest); *id.* at 1130-1131 (Ch. 25, Southwest).

⁷² *Id.* at 1059 (Ch. 24), 1130 (Ch. 25).

⁷³ *Id.* at 486-487 (Ch. 12).

⁷⁴ *Id.* at. at 900, 905 (Ch. 21).

⁷⁵ *Id.* at 880 (Ch. 21).

⁷⁶ Gordon, Kate, et al., *Heat in the Heartland: Climate Change and Economic Risk in the Midwest*, Risky Business, 33 (2015), <http://riskybusiness.org/site/assets/uploads/2015/09/RBP-Midwest-Report-WEB-1-26-15.pdf>.

⁷⁷ Wash. State of Knowledge Report, at 7-1.

- **Threats to marine industries.** The 2015 snow drought in Washington led to the largest harmful algal bloom recorded on the West Coast, closing fisheries along the entire Northwest coast.⁷⁸ In Rhode Island, warmer water in Narragansett Bay are causing iconic cold-water fish (cod, winter flounder, hake, and lobster) to move north out of Rhode Island waters and warm-water southern species (scup, butterfish, and squid) to become more prevalent, and ocean acidification due to increased CO₂ severely threatens young shellfish.⁷⁹ In Maine, rising temperatures in the Gulf of Maine have led non-native green crabs to invade and adversely impact soft-shell clam flats throughout southern and mid-coast Maine, and continued warming may cause a dramatic decline in populations of the world-famous Maine lobster, similar to the declines in lobster populations that have already been observed in the southern New England states.⁸⁰
- **Threats to regional ecosystems.** In Northeast, “decreasing seasonality” is already harming tourism, farming, and forestry,⁸¹ while Florida’s coral reefs—which support tourist industries, coastal protection, and marine habitats—likely will be lost in the coming decades.⁸² Global warming may lead to the death of 72 percent of the Southwest’s evergreen forests by 2050, and nearly 100-percent mortality of these forests by 2100.⁸³

The threats of climate change are stark. Framed in the reverse, however, these projections show the enormous opportunity that regulatory agencies like EPA have to save lives, ecosystems, and industries through sensible emissions controls. As described above, the States and Cities are already experiencing the severe effects of climate change, and further delay in reducing these risks is inexcusable. Meaningful federal action is urgently needed to protect the health and welfare of our country.

⁷⁸ Fourth Assessment, Vol. II, at 1066-67 (Ch. 24).

⁷⁹ R.I. Exec. Climate Change Coord. Council Science & Technical Advisory Board Annual Report, Current State of Climate Science in Rhode Island, at 7 (May 2016), <http://climatechange.ri.gov/documents/ec4-science-and-technical-advisory-board-report.pdf>

⁸⁰ Woodard, C., *Mayday: Gulf of Maine in Distress*, Portland Press Herald, Oct. 25, 2015, <http://www.pressherald.com/2015/10/25/climate-change-imperils-gulf-maine-people-plants-species-rely/>; Wahle, R. A., et al., “American lobster nurseries of southern New England receding in the face of climate change,” *ICES J. of Marine Sci.*, 72: i69–i78 (May 2015), <https://doi.org/10.1093/icesjms/fsv093>; Penelope Overton, *Gulf of Maine lobster boom over as population starts to decline*, Portland Press Herald, Jan. 29, 2018, https://www.sentinelsource.com/news/environment/gulf-of-maine-lobster-boom-over-as-population-starts-to/article_cc5951cf-6f95-5195-925b-0e413ac6fb5e.html

⁸¹ Fourth Assessment, Vol. II, at 675, 678 (Ch. 18).

⁸² *Id.* at 776 (Ch. 19).

⁸³ McDowell, N.G., et al., “Multi-scale predictions of massive conifer mortality due to chronic temperature rise,” in *Nature Climate Change* 6, 295-300 (Dec. 2015), <https://doi.org/10.1038/NCLIMATE2873>.

C. States' and Cities' response to the urgent need to reduce carbon dioxide emissions from the electric generating sector

The States and Cities have pursued more than a decade of litigation and regulatory efforts to limit CO₂ emissions. For instance, certain States and Cities' lawsuit to compel EPA to limit greenhouse gas emissions led the Supreme Court to rule that EPA was obliged "to regulate emissions of the deleterious pollutant" if it found that the emissions endanger public health or welfare. *Massachusetts v. EPA*, 549 U.S. 497, 528-29, 533 (2007). EPA subsequently found in 2009 that greenhouse gases, including CO₂, endanger public health and welfare by causing more intense, frequent, and long-lasting heat waves; worse smog in cities; longer and more severe droughts; more intense storms, hurricanes, and floods; the spread of disease; and a rise in sea levels.⁸⁴

While *Massachusetts* was still pending, in the *American Electric Power v. Connecticut* case certain States and Cities also brought common law public nuisance claims directly against power plants, seeking reductions in the CO₂ pollution that was harming the health and welfare of their citizens. *Am. Elec. Power Co. v. Connecticut*, 564 U.S. 410, 418 (2011) (*AEP v. Connecticut*). When *AEP v. Connecticut* reached the Supreme Court (after *Massachusetts v. EPA*), the Court held that the Clean Air Act "directly" authorized EPA to regulate CO₂ from power plants under section 111. *Id.* at 424.

The rules EPA issued in 2015 to limit CO₂ pollution from new fossil-fueled power plants under section 111(b) and existing plants under section 111(d) (the Clean Power Plan) marked the culmination of the States' and Cities' litigation to compel the agency to act. In those rules, EPA also cited the Supreme Court's recognition of EPA authority under section 111 as part of its legal justification for the regulations. *See* Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. at 64,527, 64,759 (2015 Preamble); *see also AEP v. Connecticut*, 564 U.S. at 424.

In the nearly 10 years since EPA found that greenhouse gas pollution endangers public health and welfare, the evidence that these emissions harm humans—including particularly vulnerable populations—has only grown stronger. Our states are already experiencing harms from climate change, such as flooding from rising seas, increasingly severe storms, and prolonged droughts. Unless CO₂ emissions are significantly reduced, climate change threatens to worsen these harms.

Many states have already acted to reduce CO₂ emissions from existing and future power plants within their borders. For example, through the Regional Greenhouse Gas Initiative states limit these emissions under a trading program. Also, California, New York, Oregon, and Washington impose CO₂ emission limits on new fossil-fueled power plants that are even more stringent than the Current Standard. Further, half of the states in the country have established permitting and monitoring standards for carbon capture or storage or have provided regulatory or financial incentives to promote those technologies. *See* section III.C.3, below.

Although the Fourth Assessment credits emission reduction strategies the States and Cities and others have already put into action, it concludes that current efforts "do not yet

⁸⁴ Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,497, 66,524-25, 66,532-33 (Dec. 15, 2009).

approach the scale considered necessary to avoid substantial damages to the economy, environment, and human health over the coming decades.”⁸⁵ Robust, nationwide emissions standards for power plants are vital to securing the health, safety, and prosperity of future generations of Americans.

II. OVERVIEW OF EPA’S NEW SOURCE PERFORMANCE STANDARDS FOR COAL-FIRED POWER PLANTS

A. Statutory framework

Section 111 of the Clean Air Act contains the New Source Performance Standards program, which requires EPA to regulate all categories of stationary (non-vehicle) sources that cause, or contribute significantly to, air pollution that may reasonably be anticipated to endanger public health or welfare. 42 U.S.C. § 7411(b)(1)(A) (section 111(b)). Section 111(b) requires EPA to establish standards of performance governing the emission of air pollutants from new sources, and to review and, if appropriate, revise, those standards at least every eight years. *Id.* § 7411(b)(1)(B). “Standard of performance” means “a standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.” *Id.* § 7411(a)(1). EPA sets performance standards for new sources by reference to emissions levels that can be achieved using the most up-to-date control technology or method of limiting emissions of each type of pollutant that is both feasible and achievable at a reasonable cost, but it does not mandate any specific equipment, technology, or method. *Id.* § 7411(a)(1) & (b)(5). Under the Clean Air Act, an existing source that is modified or reconstructed after regulations are proposed for new sources is also considered a new source. 42 U.S.C. § 7411(a)(2); 40 C.F.R. § 60.15.

B. Summary of current emission standards for new, modified, and reconstructed power plants and EPA’s determination of the best system of emission reduction

After analyzing an exhaustive technical rulemaking record, EPA in 2015 appropriately determined that partial CCS, in which a plant captures a portion of its CO₂ emissions for underground storage, was the best system of emission reduction that had been adequately demonstrated to control CO₂ pollution from new coal-fired plants. All of the steps involved in CCS—capture of some CO₂ from a gas stream, transportation via pipeline, and permanent storage underground—have been demonstrated and are currently in use. CCS is already in full-scale, integrated operation in the energy and chemical industries. The Current Standard is a valid, careful, and necessary exercise of EPA’s mandate in section 111(b) to regulate harmful CO₂ emissions from new, modified, and reconstructed coal-fired power plants.⁸⁶

⁸⁵ Fourth Assessment, Vol. II, at 26 (Summary Findings).

⁸⁶ The Proposed Rule does not propose any changes to the 2015 emission standards for gas-fired power plants, and EPA makes clear that it is not accepting comments on those standards. *See* Proposed Rule at 65,424/1-2 (“The EPA is not proposing to amend and is not reopening the standards of performance for newly constructed or reconstructed stationary

The Current Standard, which has now been in effect over three years, sets numerical limits on CO₂ emissions from fossil-fuel fired power plants constructed after January 8, 2014. The standard for *new* coal-fired plants—1,400 pounds of CO₂ per megawatt-hour, gross, (lb CO₂/MWh-g)—is based on the amount of CO₂, per unit of electricity, that would be emitted by a new highly efficient plant employing partial CCS. EPA determined that a new plant burning bituminous coal would need to capture approximately 16 percent of its CO₂ emissions to meet that standard, whereas a plant burning subbituminous or dried lignite coal would need to capture approximately 23 percent. 2015 Preamble at 64,513/2-3. A new plant need not use partial CCS to meet that standard, however, and EPA identified other means a source could use to meet the standard.

For *reconstructed* coal-fired plants, the emission level is “based on the performance of the most efficient generating technology for these types of units . . . , (i.e., reconstructing the boiler if necessary to use steam with higher temperature and pressure, even if the boiler was not originally designed to do so.” 2015 Preamble at 64,514/3. Based on its review of emissions from plants employing the most efficient generating technology, EPA set the standard at 1,800 lb CO₂/MWh-g for large units. Thus, the Current Standard for reconstructed coal-fired plants is not based on CCS at all.

For *modified* coal-fired power plants, the Current Standard is tied to the level of CO₂ emissions the individual plant itself has already proven it can achieve through actual experience. The numerical standard is a “unit-specific emission limit determined by the unit’s best historical annual CO₂ emission rate (from 2002 to the date of the modification).” 2015 Preamble at 65,428/3. However, the emission limit will be “no more stringent than” 1,800 lb CO₂/MWh-g. Like the standard for reconstructed plants, the Current Standard for modified plants is not based in any way on the plant employing CCS.

C. Summary of proposed emission standards

EPA’s new Proposed Rule increases the emission limit for *new* coal-fired plants from 1,400 to 1,900 lb CO₂/MWh-g. EPA proposes this new, higher emissions level by rejecting its 2015 finding that partial CCS was the best system of emission reduction (BSER) and by rejecting its 2015 determination that “business as usual” combustion technology could not be considered BSER. *See* 2015 Preamble at 64,595/1 (rejecting proposals to use “business as usual” emissions as BSER). Instead, EPA now assumes that whatever level of CO₂ is emitted by its sample of existing coal-fired plants is the best that can be achieved. EPA now points out that “25 existing EGUs have maintained annual emission rates of 1,900 lb CO₂/MWh-gross over the past 10 years.” Proposed Rule at 65,451/1. EPA admits that a level below 1,800 lb CO₂/MWh-g can be achieved at plants using a cooling tower. Proposed Rule at 65,451/3. Although the vast majority of coal-fired plants do employ cooling towers, EPA proposes a standard of 1,900 lb CO₂/MWh-g to allow a wider range of less-efficient technologies to meet the standard.

combustion turbines.”); *id.* at 65,425 n.1 (“In this proposal, in some instances, the EPA identifies an issue that the Agency has previously addressed, and states that the Agency is not reopening that issue in this proposal. The EPA will not consider such an issue as relevant to this proposal.”) These comments of the States and Cities therefore only address the standards for coal-fired plants.

For *reconstructed* coal-fired plants, the EPA proposes increasing the emission limit from 1,800 to 1,900 lb CO₂/MWh-g, apparently again on the theory that a wider range of less-efficient plant types—beyond those which EPA believed in 2015 were most likely to be constructed—should serve as the reference points. Proposed Rule at 65,449/1 (explaining that EPA is applying the same analytical framework to reconstructed plant emissions as it does to new plant emissions).

For *modified* plants, EPA ostensibly uses the same BSER as it did in 2015: a “unit-specific emission limit determined by the unit’s best historical annual CO₂ emission rate (from 2002 to the date of the modification).” However, now EPA would allow the unit to emit 1,900 lb CO₂/MWh-g (that is, 100 lb CO₂/MWh-g *more* than under the Current Standard), regardless of whether its actual best historical performance shows that the plant could have met the lower emission limit of the Current Standard.

D. Legal standard for reversing an existing regulation

For EPA’s proposed reversal of the Current Standard to be permissible under the Clean Air Act, EPA must comply with the requirements of section 111(b). *See* 42 U.S.C.

§ 7411(b)(1)(B) (requiring EPA to “revise such standards following the procedures required by this subsection for promulgation of such standards”). Thus, EPA must demonstrate that the Proposed Rule “reflects the degree of emission limitation achievable through the application of the best system of emission reduction.” *Id.* § 7411(a). EPA may not ignore section 111(b)’s technology-forcing mandate to consider only the emission limitations and percent reductions achieved in practice. *Id.* § 7411(b)(1)(B); *see also Portland Cement Ass’n v. Ruckelshaus*, 486 F.2d 375, 391 (D.C. Cir. 1973) (recognizing that section 111(b) “looks toward what may fairly be projected for the regulated future, rather than the state of the art at present”).

EPA must also, as always, adhere to the basic tenets of rational decision-making. To justify its proposal, EPA must “examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made.” *Motor Vehicle Mfrs. Ass’n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983) (*State Farm*); *see also United Food & Commercial Workers Int’l Union, Local 150-A v. NLRB*, 880 F.2d 1422, 1436 (D.C. Cir. 1989) (*United Food v. NLRB*) (explaining that agencies “must accept responsibility for clarifying and identifying the standards that are guiding its decisions”). An agency action is “arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, [or] offered an explanation for its decision that runs counter to the evidence before the agency.” *State Farm*, 463 U.S. at 43.

Moreover, where, as here, an agency proposes to reverse its former views on the proper regulatory approach, the agency must display “awareness that it is changing position,” show that “the new policy is permissible under the statute,” “believe[]” the new policy is better, and provide “good reasons” for the new policy. *FCC v. Fox Television Stations, Inc.*, 556 U.S. 502, 515 (2009) (*Fox*). When a new policy rests on factual or legal determinations that contradict those underlying the agency’s prior policy, as EPA does in this rulemaking, the agency must provide “a reasoned explanation . . . for disregarding facts and circumstances that underlay or were engendered by the prior policy.” *Id.* at 515-16; *id.* at 537 (Kennedy, J., concurring) (“An agency cannot simply disregard contrary or inconvenient factual determinations that it made in the past.”); *Air All. Houston v. EPA*, 906 F.3d 1049, 1067 (D.C. Cir. 2018). “Unexplained

inconsistency” in agency policy is “a reason for holding an interpretation to be an arbitrary and capricious change from agency practice.” *National Cable & Telecommunications Ass’n v. Brand X Internet Servs.*, 545 U.S. 967, 981 (2005) (*Brand X Internet Servs.*).

The Clean Air Act does not allow EPA to finalize a rule if it did not disclose—at the time of proposal—the rule’s “major legal interpretations and policy considerations” and the factual data, information, and documents on which it is based. *See* 42 U.S.C. § 7607(d)(3). The Act, and basic administrative rulemaking principles, do not put the burden on the public to respond to every conceivable permutation of options an agency might choose in response to comments. While a final rule should be shaped and informed by public comments, EPA’s requests for comment must not be so generalized and wide-ranging that they cannot be understood as requesting comments on an actual proposal at all.⁸⁷ *See Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 549 (D.C. Cir. 1983) (“EPA must itself provide notice of a regulatory proposal. Having failed to do so, it cannot bootstrap notice from a comment.”); *Shell Oil Co. v. EPA*, 950 F.2d 741, 760 (D.C. Cir. 1991) (“[W]hen a final rule bears little resemblance to the one proposed, the parties are deprived of their [Administrative Procedure Act] rights to notice and comment.”).

As described in the remainder of this comment letter, EPA’s regulatory about-face in the Proposed Rule falls far short of meeting these legal standards, rendering it arbitrary and capricious and unlawful.

III. EPA’S REVISED DETERMINATION OF THE BEST SYSTEM OF EMISSION REDUCTION FOR NEW COAL-FIRED POWER PLANTS IS NOT SUPPORTED BY THE RECORD OR THE CLEAN AIR ACT.

EPA explains in the Proposed Rule that its justification for reversing its position that partial CCS is BSER is “the high cost” and the “limited geographic availability” of CCS. Proposed Rule at 65,426/2. EPA states that these two factors are the foundation of its entire rationale for proposing to directly contradict the position it took in the 2015 rulemaking. In particular, EPA “bases this revision on (1) an updated analysis of what represents reasonable costs and (2) an updated analysis of the geographic availability of CCS.” *Id.* at 65,430/3. As explained below in sections III.B and III.E, each of EPA’s new analyses is conclusory, inconsistent with EPA’s significantly more robust 2015 analysis (and often even inconsistent with itself), and inadequate under court precedent governing when an agency can reverse a lawfully promulgated regulation. Furthermore, EPA’s proposal to adopt what is effectively no regulation of CO₂ at all as the “best system of emission reduction” violates the mandate Congress gave EPA in section 111 of the Clean Air Act.

⁸⁷ EPA asks for comment on such a wide variety of issues that, with respect to many substantive areas, the Proposed Rule is more akin to a request for information or an advanced notice of proposed rulemaking than it is to the notice of proposed rulemaking required by the Clean Air Act. *See*, for example, requests for comment on topics 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 34, 36, 37, 38, 39, 41, 42, 45, 54, 56, 57, and 58 in the Proposed Rule. On those subjects for which EPA is not making any proposal at all, its requests for comment do not give the public the required notice and opportunity to comment on a proposed agency action.

A. EPA has no basis to conclude that its proposed standard is based on a “system of emission reduction” that is in fact the “best” under Clean Air Act section 111. (C-3)

1. EPA fails to analyze emission increases allowed by the Proposed Rule compared to the status quo in the event that new coal-fired plants are built.

In evaluating whether a system of emission reduction is “best” under section 111, EPA must consider the quantity of emissions the system would reduce. *See Sierra Club v. Costle*, 657 F.2d 298, 326 (D.C. Cir. 1981) (stating “we can think of no sensible interpretation of the statutory words ‘best . . . system’ which would not incorporate the amount of air pollution as a relevant factor to be weighed when determining the optimal standard for controlling . . . emissions”); 2015 Preamble at 64,539/2 (“The fact that the purpose of a ‘system of emission reduction’ is to reduce emissions, and that the term itself explicitly incorporates the concept of reducing emissions, supports the [D.C. Circuit] Court’s view that in determining whether a ‘system of emission reduction’ is the ‘best,’ the EPA must consider the amount of emission reductions that the system would yield.”). When revising an existing standard, the baseline against which to measure the new standard is the level of emissions allowed under *current law*, not those emissions that would occur in the absence of any regulation. *See Air All. Houston v. EPA*, 906 F.3d at 1068 (explaining that “the baseline for measuring the impact of a change or rescission of a final rule is the requirements of the rule itself, not the world as it would have been had the rule never been promulgated”).

To properly analyze the effect of the BSER identified in Proposed Rule, therefore, EPA must take into account the emissions allowed by the Proposed Rule compared to the emissions allowed under the Current Standard. EPA nowhere analyzes the increase in CO₂ emissions over the status quo that would result in the event that new coal-fired plants are built and operated under the Proposed Rule, however. At most, it admits that emissions would increase, explaining that “[t]o the extent that new coal-fired facilities are constructed, a BSER coal facility under the proposed standard would have higher CO₂ emissions than a BSER facility under the 2015 final standards.”⁸⁸ But EPA explicitly refuses to analyze the consequences of that increase, explaining that “We do not attempt to quantify the impacts of these increased emissions or economic value of these impacts.” *Id.*

⁸⁸ U.S. EPA, Economic Impact Analysis for the Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 2-6 (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11939 (2018 Economic Impact Analysis). EPA also contradicts itself within the same document. While admitting that emissions would increase under the Proposed Rule—as compared to the Current Standard—if a new coal-fired plant were to be built, the 2018 Economic Impact Analysis also claims that “This rule is designed to set emission limits for carbon dioxide (CO₂), thereby limiting potential increases in future emissions and atmospheric CO₂ concentrations.” 2018 Economic Impact Analysis, at 2-5. Nowhere in the rulemaking docket does EPA even purport to supply evidence supporting the idea that the Proposed Rule would limit increases in CO₂ emissions or CO₂ atmospheric levels.

By failing to even assess the impacts of the Proposed Rule's change in the status quo, EPA did not meet its obligations under section 111, *Sierra Club v. Costle*, 657 F.2d at 326, and "entirely failed to consider an important aspect of the problem," *State Farm*, 463 U.S. at 43 (calling such a failure arbitrary and capricious).

2. By allowing more emissions from a source than current standards do, EPA misinterprets the "best" system of emission reduction required by Clean Air Act section 111.

In effect, the Proposed Rule does nothing more than attempt to codify the CO₂ emission levels that a range of coal-fired plants, employing different technologies and burning various grades of coal, would meet even without any CO₂ controls.

EPA determined in 2015, based on market trends, that a new coal-fired plant was likely to be supercritical pulverized coal plant. 2015 Preamble at 64,594/3 ("About 60 percent of new coal-fired utility boiler capacity that has come on-line since 2005 was supercritical and of the new capacity that came on-line since 2010, about 70 percent was supercritical."). EPA found that by "the early 2000s," "the power sector had already, at that point, transitioned to the selection of supercritical boiler technology as 'business as usual' for new coal-fired power plants." *Id.* at 64,595/1. Studies by the U.S. Department of Energy's National Energy Technology Laboratory (NETL), which EPA relied on in the 2015 rulemaking, showed that the emissions from a supercritical pulverized coal plant burning bituminous coal and using a wet cooling system, but *without* any CO₂ controls at all, would be 1,620 lb CO₂/MWh-g. *Id.* at 64,562 tbl.8.⁸⁹

In the 2015 rulemaking EPA rejected the approach of setting the standard at the level supercritical units would be expected to achieve without any CO₂ controls. 2015 Preamble at 64,595/1 ("Considering the direction that the power sector has been taking and the changes that it is undergoing, identifying a new supercritical unit as the BSER and requiring an emission limitation based on the performance of such units thus would provide few, if any, additional CO₂ emission reductions beyond the sector's 'business as usual'."). But now, by setting the standard at the level new, modern plants would be expected to achieve without any CO₂ controls at all, EPA is reversing itself and proposing to enshrine the rejected "business as usual" emissions as the best that a plant can do.

⁸⁹ Table 8 of the 2015 Preamble cites the source of the 1,620 lb CO₂/MWh-g figure as the June 22, 2015, NETL study, which lists 1,618 lb CO₂/MWh-g for "case B12A." NETL, Cost and Performance Baseline for Fossil Energy Plants Supplement: Sensitivity to CO₂ Capture Rate in Coal-Fired Power Plants, No. DOE/NETL-2015/1720 (June 22, 2015), at Ex. A-1. Case B12A assumes a supercritical pulverized coal plant operating at an 85-percent capacity factor, using wet cooling and wet scrubber, with no CO₂ capture at all. NETL, Cost and Performance Baseline for Fossil Energy Plants Volume 1a: Bituminous Coal (PC) and Natural Gas to Electricity Revision 3, No. DOE/NETL-2015/1723, at 115 & tbl.3-45 (July 6, 2015).

Note that the text of the 2015 Preamble contains a typographical error listing this emission rate as "1,720" instead of 1,620 lb CO₂/MWh-g. *Compare* 2015 Preamble at 64,594/3 *with* 2016 Reconsideration Denial, at 16 n.43 ("There is a typographical error in the final preamble at 80 FR 64594/3, stating '1,720' instead of the correct '1,620'.").

Although EPA in 2018 shirks its duty to analyze the consequences of its proposed “business as usual” level of emissions, EPA in 2015 did determine what would be gained by imposing CO₂ controls on new coal-fired power plants. EPA found that “a new highly efficient 500 MW coal-fired SCPC [supercritical pulverized coal] meeting the final standard of 1,400 lb CO₂/MWh-g will emit about 354,000 fewer metric tons of CO₂ each year than that new highly efficient unit would have emitted otherwise. That is equivalent to taking about 75,000 vehicles off the road each year and will result in over 14,000,000 fewer metric tons of CO₂ in a 40-year operating life.” 2015 Preamble at 64,574/3. Because the Proposed Rule would allow CO₂ emissions to reach the “business as usual” level, these 2015 figures indicate the magnitude of the emission increases to be expected if the Proposed Rule replaces the Current Standard.

This expected emission increase shows that the Proposed Rule does not comply with Congress’s command to EPA to base any section 111 standard—whether initial or, as here, revised—on the best system of emission reduction. It would require quite unusual circumstances indeed for a system that would allow emissions to *increase* to be considered the “best” system of emission *reduction*, and EPA has not attempted to show those circumstances exist now. As the D.C. Circuit Court observed in *Sierra Club v. Costle*, 657 F.2d at 326, “[c]ontrol technologies cannot be ‘best’ if they create greater problems than they solve.” In proposing the new BSER here, EPA fails to heed the *Costle* court’s warning.

B. EPA’s proposed determination that the cost of partial CCS is “unreasonable” is not supported by fact or law. (C-28)

In developing the Current Standard in 2015, EPA conducted a multifaceted economic analysis of the cost of meeting that standard and found it to be reasonable. EPA analyzed the cost of complying with the standard on both source-specific and industry-wide/national bases and explained its methods and conclusions in a detailed Regulatory Impact Analysis.⁹⁰ EPA evaluated capital costs on a per-plant basis, the effect on a new plant’s levelized cost of electricity⁹¹ (LCOE), and overall cost impacts to the industry as a whole. Under all of these metrics, EPA found the cost of complying with the Current Standard to be reasonable. 2015 Preamble at 64,558-73. In its analyses EPA made various assumptions that would have tended to overestimate the cost of complying with the Current Standard. EPA included the extra cost due to high-risk financing structures, but it excluded offsets to compliance costs from enhanced oil recovery revenue and tax incentives.⁹²

⁹⁰ U.S. EPA, Regulatory Impact Analysis for the Final Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units (Aug. 2015), Docket ID EPA-HQ-OAR-2013-0495-11877 (2015 Regulatory Impact Analysis).

⁹¹ “The LCOE is a commonly used economic metric that takes into account all costs to construct and operate a new power plant over an assumed time period and an assumed capacity factor. The LCOE is a summary metric, which expresses the full cost of generating electricity on a per unit basis (i.e., megawatt-hours).” 2015 Preamble at 64,560/2-3.

⁹² EPA explained in the 2015 Preamble that its cost estimates included “a number of conservative elements.” “In particular, these estimates include the highest value in the projected range of potential costs for partial CCS. They do not reflect revenues which can be generated by

Linking its finding of cost-reasonableness to governing D.C. Circuit case law on consideration of costs under section 111, EPA explained in the 2015 Preamble that “[i]n this rulemaking, our determination that the costs are reasonable means that the costs meet the cost standard in the case law no matter how that standard is articulated, that is, whether the cost standard is articulated through the terms that the case law uses, *e.g.*, ‘exorbitant,’ ‘excessive,’ etc., or through the term we use for convenience, ‘reasonableness.’” 2015 Preamble at 64,559 n.255. In the 2018 Proposed Rule, EPA confirmed that it was bound by the same legal standard: when it determines that the cost of required emission reduction is “reasonable,” it means that the cost is “well within the bounds established by [D.C. Circuit] jurisprudence.” Proposed Rule at 65,433/2. That is, the cost is not “exorbitant,” *Lignite Energy Council v. EPA*, 198 F.3d 930, 933 (D.C. Cir. 1999), “greater than the industry could bear and survive,” *Portland Cement Ass’n v. EPA*, 513 F.2d 506, 508 (D.C. Cir. 1975), “excessive,” or “unreasonable,” *Sierra Club v. Costle*, 657 F.2d at 343.

EPA now proposes to reverse its finding that the cost of compliance is reasonable on two grounds: First, after EPA applied new assumptions to the preexisting cost data it used in 2015, it feels that the *LCOE* for a plant using partial CCS is too high; second, after reversing course and adopting the industry arguments it explicitly rejected in 2015 concerning the exact same capital cost data it relied on before, it now feels those *capital costs* are too high. Proposed Rule at 65,435-41. EPA does not even suggest, however, that any coal-fired plant was not built due to the Current Standard being too expensive; indeed, EPA believes that no such plants will be built under either the current or proposed standards over the time periods analyzed. EPA’s change of position on the reasonableness of the cost of the Current Standard is arbitrary and capricious as it appears to be based on improperly inflated costs and unjustified—and often even unacknowledged—reversals of its 2015 positions. Even if EPA’s new approach was accurate and consistent with principles of reasoned rulemaking, however, none of EPA’s new cost calculations is sufficient to support its conclusion that the cost of partial CCS is so great that it should not be considered BSER.

1. EPA improperly inflates the LCOE of a coal-fired plant employing partial CCS and fails to justify its new methodology.

One of the factors EPA used in its 2015 analysis to determine that the cost of the Current Standard was reasonable was a comparison of the *LCOE* of a new coal-fired plant with partial CCS to the *LCOE* of a new nuclear plant. EPA considered this to be a worthwhile comparison to determine the reasonableness of the cost of the Current Standard because, if a developer were to build an intermediate or base-load plant that was not gas-fired, then nuclear power would be the

selling captured CO₂ for enhanced oil recovery, and reflect the costs of partial CCS rather than potentially less expensive alternative compliance paths such as a utility boiler co-firing with natural gas.” 2015 Preamble at 64,563/2. *See also id.* at 64,564/2 (“[W]e do not . . . rely on any cost reduction opportunities to justify the costs of meeting the standard as reasonable, but again note the conservative assumptions embodied in our assessment of compliance costs.”); *id.* at 64,565/1 (“The EPA thus again notes that the cost assumptions it is making in its BSER determination are conservative. That is, by costing partial CCS as BSER, the EPA may be overestimating actual compliance costs since there exist other less expensive means of meeting the promulgated standard.”).

most likely alternative to coal-fired power. *See* section III.B.2.a, below. By comparing the LCOE of a coal-fired plant with partial CCS to that of a new nuclear plant, EPA concluded in 2015 that the costs of the Current Standard were reasonable. 2015 Preamble at 64,561/1.

In the Proposed Rule, however, EPA arbitrarily manipulates preexisting, reliable government cost data to artificially increase the LCOE of a coal-fired plant meeting the Current Standard, thereby making partial CCS appear relatively more costly than it did in its 2015 analysis. EPA then improperly uses this inflated LCOE to attempt to show that the cost of meeting the Current Standard is unreasonable in comparison both to a nuclear plant and to a coal-fired plant that does not meet the standard. EPA concedes that its change of position in the Proposed Rule is not based on any new cost data developed since the 2015 rulemaking. Proposed Rule at 65,437/3 (“The EPA is not aware of any more recent, detailed, or transparent costing analysis specific to coal-fired EGUs with or without carbon capture technology.”). Instead, EPA merely massages the NETL data—which in 2015 and still in 2018 EPA claims to be the best available—into LCOE figures it believes support changing its position on the cost-reasonableness of partial CCS.

The cost figures EPA relied on for coal-fired plants in 2015 were based on LCOE analyses performed by NETL. EPA said that “NETL cost and performance characteristics were selected for coal-fired technologies because the NETL estimates were unique in the detail of their cost and performance estimates for a range of CO₂ capture levels” for coal-fired plants. 2015 Regulatory Impact Assessment, 4-21 to 4-22. “The EPA relied on those sources because the NETL studies are the most comprehensive and transparent of the available cost studies and NETL has a reputation in the power sector industry for producing high quality, reliable work.” 2015 Preamble at 64,567/1. EPA states in *both* its 2015 Regulatory Impact Analysis (page 4-22) and its 2018 Economic Impact Analysis (page 3-21) that the “use of the NETL cost and performance characteristics allows for comparisons to be made across generating technologies using a single, internally-consistent framework.” And, as EPA explains in its 2018 Economic Impact Analysis, “[t]he value of the [NETL LCOE] studies lies not in the absolute accuracy of the individual case results but in the fact that all cases were evaluated under the same set of technical and economic assumptions. This consistency of approach allows meaningful comparisons among the cases evaluated.” 2018 Economic Impact Analysis, at 3-22 tbl.3-7, notes.

The NETL cost data EPA relied on in the 2015 rulemaking assumed that a new coal-fired plant would operate at an 85-percent capacity factor.⁹³ Indeed, even EPA’s new 2018 Economic

⁹³ In the Proposed Rule EPA explains that for the LCOE calculations in the 2015 rulemaking it assumed a constant capacity factor of 85 percent “consistent with the NETL LCOE calculations.” Proposed Rule at 65,438/2 & n.70. *See also* 2015 Preamble at 64,573/1 (“In determining the predicted cost and performance of [partial CCS at a level sufficient to meet the Current Standard], the EPA utilized information contained in updated DOE/NETL studies that assumed use of bituminous coal and an 85 percent capacity factor.”). Specifically, the 2015 Preamble also, at page 64,562, footnote 275, cites to the sources of the LCOE figures EPA relied on. For a coal-fired plant, EPA relied on “Cost and Performance Baseline for Fossil Energy Plants Supplement: Sensitivity to CO₂ Capture Rate in Coal-Fired Power Plants,” No. DOE/NETL–2015/1720 (June 22, 2015), which explains on page 7 that the “plants are evaluated

Impact Analysis relies entirely on data that assumes that a new coal-fired plant will operate at an 85-percent capacity factor. 2018 Economic Impact Analysis, at 3-21 n.18 (“The LCOE calculations used in this analysis all assume an 85 percent capacity factor and do not use the adjusted capacity factor approach discussed in the preamble accompanying this action.”).⁹⁴

In the Proposed Rule, however, EPA recalculates the capital cost component of the LCOE by assuming that a coal-fired plant employing partial CCS will operate at a 76.6-percent (instead of 85-percent) capacity factor. By using this lower capacity factor, EPA inflates the capital cost component of LCOE even while ostensibly using the same capital cost data it used in 2015. EPA starts with the same NETL capital cost assumptions that it did in the 2015 rulemaking. But, holding all other factors constant, as EPA does, a power plant operating at 76.6-percent capacity generates 10 percent fewer megawatt-hours of electricity than one operating at 85-percent capacity. By spreading that same capital cost over fewer megawatt-hours of electricity, EPA now creates an artificially high capital component to the LCOE calculation.⁹⁵

When EPA then compares the coal-fired plant’s newly inflated LCOE to a new nuclear plant’s LCOE, it concludes that the coal-fired plant is too expensive relative to the nuclear plant. EPA also compares the new higher LCOE to that of a coal-fired plant without CCS and finds that employing partial CCS is too expensive. *See* section III.B.2.a, below.

EPA fails to justify its change of position on assumed power plant capacity and its rejection of the NETL 85-percent assumption. For the Proposed Rule EPA assumes that a new coal-fired plant with partial CCS would not be price competitive and would only operate at a 76.6 percent capacity factor as a result. Proposed Rule at 65,438-39. EPA does not even mention this new economic assumption in its 2018 Economic Impact Analysis, and instead explicitly states that the document does not analyze changes to capacity factors. 2018 Economic Impact Analysis, at 3-21 n.18. EPA’s explanation directly contradicts its 2015 understanding of the economics of building and operating a coal-fired plant, and the agency does not explain why it is rejecting its previous understanding.

EPA determined in 2015 that if new coal-fired plant were to be built in the future, it would be to supply base load electricity, not to dispatch on an as-needed basis. In both 2015 and 2018 EPA determined that low natural gas prices (compared to coal) for the foreseeable future

at a rated net power of 550 MWe with an assumed capacity factor of 85 percent.” Docket ID EPA-HQ-OAR-2013-0495-11950, Att. 2.

⁹⁴ A cursory December 2018 EPA memorandum included in the rulemaking docket alludes to the assumption of “a 100% capacity factor” in EPA’s new transmission and storage cost calculations, but EPA does not explain where that assumption comes from or how it affects EPA’s figures. U.S. EPA, Memorandum, EPA’s approach for estimating transportation and storage (T&S) costs for various amounts of carbon capture and storage, Exs. 2, 4, 5 (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11949 (2018 T&S Memorandum).

⁹⁵ *See* Comments of the Electric Power Research Institute on the Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, 9 (May 9, 2014) (“Spreading the large capital costs of coal plus CCS over many fewer hours would significantly increase its LCOE . . .”), Docket ID EPA-HQ-OAR-2013-0495-8925.

mean that developers of new electricity generation likely would not build a new coal-fired plant at all, regardless of whether the Current Standard applied.⁹⁶ However, then and now, EPA believes that some developer may build a new coal-fired plant for non-economic reasons, such as for the purpose of so-called fuel diversification. *See* section VI.C.2, below. Like nuclear plants, coal-fired plants “have historically supplied ‘base load’ electricity, the portion of electricity loads which are continually present, and typically operate throughout all hours of the year. The coal units meet the part of demand that is relatively constant.” 2015 Regulatory Impact Assessment, 2-5. EPA found that a new coal-fired plant “—if constructed—would, most likely, be built to serve base load power demand and would not be expected to routinely start-up or shutdown or ramp its capacity factor in order to follow load demand.” 2015 Preamble at 64,573/3; *id.* at 64,614 n.535. EPA already considered comments that a new coal-fired plant with CCS would not be cost competitive in a deregulated market, and it responded that “given current and projected market conditions, any new coal-fired EGU would likely only be built in a location where it would be expected to operate at a high capacity factor (e.g., as a base load unit).” Proposed Rule at 65,438 (explaining EPA’s 2015 position). Regarding the ability of new coal-fired plants to compete in a deregulated market, EPA explained there was no basis to assume that a new coal-fired plant with partial CCS would not be competitive in the market but that one without partial CCS would be competitive. Instead, EPA reiterated that a new coal-fired plant would not be able to compete on price regardless of whether the Current Standard was in place.⁹⁷

In the 2018 Proposed Rule preamble, however, EPA reverses course and assumes that a new coal-fired plant with partial CCS would be built to compete on price with other generators. Proposed Rule at 65,438-39. But EPA never supplies any information to support the idea that anyone will build a new coal-fired plant to compete in the marketplace based on price. Instead, its position is consistent between 2015 and 2018 that coal-fired plants will not be built for economic reasons under any reasonable fuel price scenario. EPA’s sole basis for even considering a reevaluation of its assumptions about capacity factors is its blithe claim that “an increasing number of coal-fired power plants are changing from base load to variable load.” Proposed Rule at 65,439/1. Whether or not this is accurate, it is irrelevant because it describes the behavior of operators of *existing* power plants in response to market conditions. EPA never claims, nor provides supporting evidence, that a developer of *new* generating capacity would build a coal-fired plant to operate as a variable load source instead of as a base load source with a high capacity factor.

Instead of providing evidence or analysis to disprove its 2015 findings, EPA simply assumes its previous determination that a hypothetical new coal-fired plant would supply base

⁹⁶ *See* 2015 Preamble at 64,563/1 (“Under current and anticipated market conditions, power providers that are considering costs alone in choosing a fuel source for new intermediate or base load generation will choose natural gas because of its competitive current and projected price.”); 2018 Economic Impact Analysis, at 3-28 (“[N]atural gas price projections need to be notably higher than the highest price projection in the [U.S. Energy Information Agency’s Annual Energy Outlook model for] 2018 scenarios before market dynamics would be expected to favor new coal generation over natural gas generation.”).

⁹⁷ *See* U.S. EPA, Response to Comments on January 8, 2014 Proposed Rule, Response 3.3-3, at 3 70 (Aug. 3, 2015), Docket Nos. EPA-HQ-OAR-2013-0495-11860 through -11874 (2015 RTC).

load power was wrong, and it arbitrarily lowers the assumed capacity factor to 76.6 percent. *See Butte Cty., Cal. v. Hogen*, 613 F.3d 190, 194 (D.C. Cir. 2010) (“The agency’s statement must be one of ‘reasoning’; it must not be just a ‘conclusion’; it must ‘articulate a satisfactory explanation’ for its action.”). EPA should cease manipulating preexisting cost data in the manner it proposes and instead “use the NETL costs without any significant adjustments, similar to the approach used in the 2015 Rule,” which EPA proposes as an alternative measure of costs. Proposed Rule at 65,437/3. At the very least, to avoid arbitrary and capricious rulemaking, EPA must not base its calculations on unexplained and inconsistent assumptions.

2. Even if correct, EPA’s revised LCOE calculations are not substantially different from its 2015 calculations and therefore cannot support EPA reversing its previous finding that the cost of partial CCS is comparable to other rulemakings and is reasonable.

EPA says that the first cost-based justification for reversing its finding that partial CCS is BSER is EPA’s new LCOE analysis. This analysis purports to show that—based on EPA’s new inflation of LCOE cost components and other changed assumptions—the LCOE of a plant with partial CCS is higher than what it thought in 2015. Proposed Rule at 65,440/1. EPA’s second cost-based justification is that—without presenting any new data or analysis—the capital cost of building a new coal-fired plant with partial CCS seems too high. *Id.* at 65,441. Even if EPA’s new cost figures are correct, EPA fails to provide a reasoned explanation for reversing its position that partial CCS is BSER. *See Fox*, 556 U.S. at 515.

a. EPA’s new LCOE figures do not support its new view that partial CCS is not cost-reasonable.

In the 2015 rulemaking EPA compared the LCOE of a new coal-fired plant with partial CCS to the LCOE of a new nuclear plant and found the cost of partial CCS to be reasonable. EPA considered this an appropriate comparison because both technologies would be “reasonably anticipated to be designed, constructed, and operated for a similar purpose—that is, to provide dispatchable base load power that provides fuel diversity by relying on a fuel source other than natural gas.” 2015 Preamble at 64,562. EPA explained in 2015 that comparing the LCOE of two generating technologies “is appropriate when they can be assumed to provide similar services and similar values of electricity generated.” *Id.* at 64,561/2. “Use of the LCOE as a comparison measure is appropriate where the facilities being compared would serve load in a similar manner.” *Id.* EPA’s view of when an LCOE comparison is appropriate is unchanged. *See* 2018 Economic Impact Analysis, at 3-19 (“Evaluating competitiveness based on the LCOE is particularly useful in establishing cost comparisons between generation types with similar operating characteristics but with different cost and financial characteristics.”).

The LCOE ranges EPA evaluated to make this comparison in 2015 are excerpted below from Table 8 (page 64,562) of the 2015 Preamble (also reproduced in the Proposed Rule in Table 4 (pages 65,436-37)):

Predicted Cost and CO₂ Emission Levels for a Range of Potential New Generation Technologies

New generation technology	Emissions (lb CO ₂ /MWh-gross)	LCOE (\$/MWh)
SCPC – no CCS (bit)	1,620	76-95
SCPC + ~16% CCS (bit)	1,400	92-117
Nuclear (EIA)	0	87-115
Nuclear (Lazard)	0	92-132
IGCC [coal-fired]	1,430	94-120

Since the LCOE of a new coal-fired plant with partial CCS was estimated to be \$92 to \$117 per megawatt-hour, while the LCOE of a new nuclear plant was estimated to be \$87 to \$132 per megawatt-hour (using the range of two estimates), EPA concluded that “we project the LCOE for new fossil steam [i.e., coal-fired] capacity meeting the final 1,400 lb CO₂/MWh-g standard to be substantially similar to that for a new nuclear unit, the principal other alternative to natural gas to provide new base load power.” *Id.* at 64,562/1. EPA concluded that the LCOE comparison showed that cost of the Current Standard was reasonable and “in line with power sources that provide analogous services.” *Id.* at 64,562/1-63/2.

In the Proposed Rule, however, EPA claims that its new, slightly higher LCOE for a coal-fired plant with partial CCS “support[s] EPA’s proposal to revise the 2015 determination that partial CCS is BSER for coal-fired” plants. Proposed Rule at 65,440/1. EPA is incorrect. That conclusion is irrational and not supported by even the new figures EPA purports to rely on.

(i) EPA does not provide LCOE figures or calculations that support its claim that LCOE of a coal-fired plant with partial CCS is now 10 percent greater than that of a nuclear plant.

EPA now claims that the Current Standard is not cost-reasonable because EPA’s new, higher LCOE figures for a plant using partial CCS “are over 10 percent higher than the nuclear cost metric.” 2015 Preamble at 65,440/1. This statement is unsupported both because EPA never explains what “nuclear cost metric” it could be referring to and because the nuclear cost metrics it does cite show that the LCOE of partial CCS is still within the range of a nuclear plant’s LCOE. Thus, the cost comparison to nuclear power does not provide EPA any basis for reversing its position that partial CCS is BSER.

As a preliminary matter, EPA does not explain of how it calculated its new \$105.4 per megawatt-hour LCOE for a new coal-fired plant with partial CCS. This figure, which is the basis for all of EPA’s new claims that partial CCS is unreasonably costly on the basis of LCOE comparisons, appears only a single time in the Proposed Rule, in Table 7, with no accompanying explanation. Neither the 2018 Regulatory Impact Analysis nor the cursory 2018 T&S Memorandum on revised LCOE methodology even mentions this new figure, which is the lynchpin of EPA’s new rationale for reversing its finding that the Current Standard can be achieved at a reasonable cost. EPA’s failure to explain the foundation of its reversal of position is a violation of the Clean Air Act’s rulemaking procedures. *See* 42 U.S.C. § 7607(d)(3)

(requiring EPA to publish, as part of a proposed rulemaking, “the factual data on which the proposed rule is based,” and to include “in the docket on the date of publication of the proposed rule” relevant “data, information, and documents”).

Second, EPA’s new, higher \$105.4-per-megawatt-hour LCOE for a new coal-fired plant with partial CCS is obviously within the LCOE range for nuclear power of \$87 to \$132 per megawatt-hour EPA relied on in 2015; indeed, it is firmly in the *center* of that range. *Compare* Proposed Rule at 65,436-37 tbl.4, *with id.* at 65,439 tbl.7. It is irrational for EPA to change its position on the reasonableness of the cost of partial CCS compared to nuclear when even its revised cost is within the range EPA said was evidence of reasonableness. *See City of Kansas City v. Dep’t of Housing & Urban Dev.*, 923 F.2d 188, 194 (D.C. Cir. 1991) (agency decision “cannot survive review” when based on a factual premise contradicted by the record).

Third, if there is some other “nuclear cost metric” to which EPA is comparing its new, higher partial CCS figure, it keeps it a secret from the public, in violation of the Clean Air Act’s rulemaking procedures. *See* 42 U.S.C. § 7607(d)(3). Neither the Proposed Rule nor 2018 Regulatory Impact Analysis nor the 2018 T&S Memorandum on revised LCOE methodology even mentions another nuclear LCOE figure other than the ones EPA relied on in 2015 (i.e., \$87 to \$132 per megawatt-hour).

Fourth, basing a cost-reasonableness analysis on a single figure (here, \$105.4 per megawatt-hour) is contrary to EPA’s position on how to compare LCOE estimates between nuclear and coal-fired power. In the 2015 rulemaking, EPA explained its approach to this LCOE comparison as follows:

Other commenters noted that the NETL studies present costs as a range, and urged the EPA not to use point estimates for these figures. EPA agrees with these comments, and is using the range of cost estimates presented in its assessment of costs. *See, e.g.,* Table 8 to the preamble to the final rule. In this regard, the EPA notes that costs for nuclear power are also presented as a range. This approach is consistent with expert advice to EPA from the EIA, and with the methodology used by leading techno-economic modelers in the field, notably Lazard Global Power and the Global CCS Institute.

2015 RTC, Response 6.3-261, at 6-173. EPA fails to explain why it is changing its methodology and does not even acknowledge that it is doing so. *See Fox*, 556 U.S. at 515 (requiring an agency to show, at a minimum, an “awareness that it is changing position”); *Brand X Internet Servs.*, 545 U.S. at 981 (explaining that “unexplained inconsistency” in agency policy is “a reason for holding an interpretation to be an arbitrary and capricious change from agency practice”).

Finally, EPA’s statement that “even with only the T&S [transmission and storage] adjustment, the revised LCOE are five percent higher than the nuclear metric” is similarly without support. Proposed Rule at 65,440/1. EPA’s assertion that just a portion of its recalculated LCOE is higher than nuclear costs is as nonsensical as its assertion regarding its whole recalculated LCOE, for the reasons described above in this section.

(ii) EPA does not provide any justification for its conclusion that a 10-percent difference between the LCOE of a coal-fired plant with partial CCS and the LCOE of a nuclear plant renders the cost of partial CCS unreasonable.

Further, even if—arithmetic and supporting evidence to the contrary—EPA is correct that there is now a 10-percent difference between the LCOE of a new coal-fired plant with partial CCS and a nuclear plant, EPA’s position has been that a difference of that magnitude is not enough to change its determination that the cost of the Current Standard is reasonable. If EPA is changing that position, it must acknowledge that it is doing so and provide a reasoned explanation for why it is doing it, *Fox*, 556 U.S. at 515, neither of which it has done in this proposal.

EPA’s change of heart in the Proposed Rule, grounded on an alleged 10-percent cost difference between the LCOE of a nuclear plant and a plant with partial CCS, is contrary to the position it took just a year-and-a-half earlier when it denied petitions to reconsider this rule on the same grounds.⁹⁸ In December 2015 a power industry trade association, the Utility Air Regulatory Group (UARG), petitioned EPA to reconsider the Current Standard on the ground that EPA had failed to properly consider the reasonableness of the capital costs of building a coal-fired plant with partial CCS.⁹⁹ In its petition, UARG argued that the range of capital costs for a coal-fired plant with partial CCS should be higher than the range that EPA had analyzed in the 2015 rulemaking and determined was reasonable. UARG’s projection of LCOE for a new coal-fired plant with partial CCS was \$98 to \$123 per megawatt-hour, an increase over EPA’s projection of \$92 to \$117 per megawatt-hour. 2016 Reconsideration Denial, at 25 n.57. EPA concluded that even if UARG’s numbers were right, EPA’s LCOE analysis still showed that the cost of a new coal-fired plant with partial CCS was reasonable as compared to a new nuclear plant. Specifically, EPA pointed out that UARG’s \$98-to-\$123 figure was within the LCOE range for a nuclear plant in the Lazard analysis (\$92 to \$132), which EPA relies on in both the 2015 Preamble and in the Proposed Rule,¹⁰⁰ and therefore the LCOE was “reasonable using the rationale applied in both the proposal and the final rule.” *Id.* at 25. “[E]ven if the EPA were to accept UARG’s alternative analysis—which we do not—we would not reach the conclusion that

⁹⁸ See U.S. EPA, Basis for Denial of Petitions to Reconsider the CAA Section 111(b) Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Utility Generating Units (Apr. 2016), Docket ID EPA-HQ-OAR-2013-0495-11918 (2016 Reconsideration Denial).

⁹⁹ UARG describes itself as “a voluntary group of electric generating companies and national trade associations. The vast majority of electric energy in the United States is generated by individual members of UARG or other members of UARG’s trade association members.” Utility Air Regulatory Group Petition for Reconsideration of EPA’s “Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units,” 80 Fed. Reg. 64,510 (Oct. 23, 2015), December 22, 2015, at 1, Docket ID EPA-HQ-OAR-2013-0495-11894.

¹⁰⁰ See 2015 Preamble at 64,562 tbl.8 (line item “Nuclear (Lazard)”; Proposed Rule at 65,436 tbl.4 (same).

the resulting re-estimated costs are unreasonable.” 2016 Reconsideration Denial, at 25. Moreover, EPA explained that its cost-reasonableness analysis does not include a “break point” beyond which a coal-fired plant’s LCOE would render the cost to meet the Current Standard per se unreasonable. Instead, “EPA promulgated a final standard of performance with a projected cost range that is consistent with projected cost ranges for other competing generation technologies. However, the EPA did not find—nor ever suggest—that costs above those ranges are unreasonable or exorbitant.” *Id.*

For EPA now to claim that that a 10-percent difference in LCOE renders the cost of the Current Standard unreasonable, it has necessarily rejected, *sub silentio*, the position it held as recently as 2016. This it cannot do. *Fox*, 556 U.S. at 515 (requiring an agency to show, at a minimum, an “awareness that it is changing position”).

In addition, EPA seems to contradict itself just within the four corners of the Proposed Rule as to whether nuclear power is cheaper than a coal-fired plant employing partial CCS. While it tries to justify reversing itself on the reasonableness of the cost of partial CCS on the ground that it is now slightly more expensive than nuclear power, EPA also claims that the LCOE of nuclear power may be so expensive that it might not be appropriate to compare it to partial CCS. EPA says that “more recent information, since the 2015 Rule, indicates that the LCOE of a new nuclear EGU is in fact higher than what developers may be willing to accept.” Proposed Rule at 65,437/2. The only “more recent information” EPA cites is claims that some nuclear reactors under construction are “over budget and behind schedule” and some projects have been abandoned; EPA provides no new LCOE analysis for nuclear plants. It is irrational for EPA to base its conclusion that a new coal-fired plant with partial CCS costs more than a nuclear plant while simultaneously saying that a nuclear plant may be even more expensive than it thinks.¹⁰¹ See *Sierra Club v. EPA*, 884 F.3d 1185, 1195 (D.C. Cir. 2018) (finding arbitrary and capricious EPA’s decision to revise an existing standard based on data it said was unreliable).

Finally, EPA has not demonstrated that it is proper to use the LCOE metric to compare the cost of two types of plants that are operating at different capacity factors. In the preamble to the 2015 rule, EPA stated that “[u]se of the LCOE as a comparison measure is appropriate where the facilities being compared would serve load in a similar manner.” 2015 Preamble at 64561/2. Because EPA is now assuming, for some purposes, a lower 76.6-percent capacity factor for coal-fired plants with partial CCS and a 90-percent capacity factor for nuclear plants, see Proposed Rule at 65437 n.64, the two hypothetical plants would be providing different levels of electricity and provide different value to the electrical grid, rendering a direct comparison of the LCOE figures of questionable relevance. EPA errs in grounding its new cost-reasonableness analysis on this comparison without providing a justification for the change.

¹⁰¹ EPA also requests comment on whether nuclear power should even be compared to coal-fired partial CCS for a developer seeking “fuel diversity.” Proposed Rule at 65,437 (requests for comment C-6 and C-7.) The States and Cities are not aware of any reason EPA should change from its 2015 position that nuclear power plants can serve as a comparison point for new coal-fired plants.

(iii) EPA does not provide any justification for concluding that an increase in the difference between LCOE of a coal-fired plant with partial CCS and one without renders the cost of partial CCS unreasonable.

EPA also now claims that a second new LCOE comparison supports it reversing its 2015 position that the cost of partial CCS is reasonable. In the Proposed Rule EPA compares its newly revealed LCOE for a coal-fired plant with partial CCS (\$105.4 per megawatt-hour) with the LCOE of a coal-fired plant without CCS (\$81.7 per megawatt-hour). This 29-percent difference, along with its LCOE comparison to nuclear, described above, “support[s] the EPA’s proposal to revise the 2015 determination that partial CCS is BSER for coal-fired EGUs.” Proposed Rule at 65,439 tbl.7 & 65,440/1. This comparison suffers from many of the same failures as EPA’s nuclear cost comparison and renders EPA’s reversal of position on the reasonableness of the cost of partial CCS arbitrary and capricious.

Even accepting EPA’s new opaque LCOE calculation as correct, EPA does not show how it supports reversing its position that the cost of implementing partial CCS is reasonable. EPA never explains why its new \$105.4-per-megawatt-hour figure is so different from its previous range for partial CCS (\$92 to \$117 per megawatt hour)¹⁰² that it should change its mind on the reasonableness of the cost of partial CCS. Indeed, as with the nuclear cost comparison, the new \$105.4 figure is right in the center of the \$92-to-\$117 range EPA still cites.

To the extent that EPA believes it should reject the NETL cost ranges it previously relied on—a view EPA never expresses—even the single-figure cost comparison EPA now promotes does not support its reversal of position. According to the Proposed Rule’s Table 7¹⁰³ (page 65,439-40), EPA previously believed that adding partial CCS to a new coal plant would increase its LCOE by 18 percent (from \$81.7/MWh to \$96.2/MWh) but that with its new \$105.4 figure, it now believes the resulting increase in LCOE to be 29 percent (from \$81.7/MWh to \$105.4/MWh).¹⁰⁴ EPA says this increase above its previous understanding renders the cost of partial CCS unreasonable. Proposed Rule at 65,440. Nowhere, however, does EPA explain why or how it determined that, while an 18-percent increase in LCOE was reasonable, a 29-percent increase is so unreasonable that it must scrap the Current Standard. EPA fails to provide any metric or methodology to guide its decision making here. *See United Food v. NLRB*, 880 F.2d at

¹⁰² 2015 Preamble at 64,562 tbl.8; Proposed Rule at 65,436-37 tbl.4.

¹⁰³ The table is oddly entitled “Predicted Cost and CO₂ Emission Levels for a Range of Potential New Generation Technologies,” although CO₂ emission levels are not shown.

¹⁰⁴ EPA’s reporting that it previously assumed \$96.2 per megawatt hour is itself suspect. Instead, it appears that in 2015 EPA believed that one way to express the LCOE for a coal-fired plant with partial CCS was \$99 per megawatt hour. *See* 2015 Preamble at 64,565 tbl.9 (citing to Cost and Performance Baseline for Fossil Energy Plants Supplement: Sensitivity to CO₂ Capture Rate in Coal-Fired Power Plants, DOE/NETL-2015/1720 (June 2015), which shows \$82 and \$99 figures in Exhibit 3-3 on page 11). Comparing \$81.7 to \$99 per megawatt-hour yields an increase of 21 percent, not the 18 percent EPA reports in the Proposed Rule. Of course, EPA also does not explain how to reconcile its assumption that a 21-percent increase is reasonable with its new conclusion that a 29-percent increase is unreasonable.

1436 (agencies “must accept responsibility for clarifying and identifying the standards that are guiding its decisions”). EPA also fails to even acknowledge that it is in effect rejecting its position, reaffirmed in 2016, that cost comparisons should not be based on a bright-line numerical cut-off. *See Fox*, 556 U.S. at 515 (requiring an agency to show, at a minimum, an “awareness that it is changing position”).

b. EPA does not justify changing its position on the reasonableness of the capital cost of partial CCS.

In addition to the analysis of LCOE of a new coal-fired plant with partial CCS, in 2015 EPA also considered the effect of the Current Standard on the capital cost alone.¹⁰⁵ EPA performed this analysis at the request of the electricity generating industry. 2015 Preamble at 64,559/3 (“[E]xtensive comment from industry representatives and others noted persuasively that fossil-steam units are very capital-intensive projects and recommended that a separate metric, solely of capital costs, be considered by the EPA in evaluating the final standard’s costs.”).

EPA determined that the partial CCS on which the Current Standard is based would increase the capital costs of a new coal-fired plant by 21 to 22 percent. 2015 Preamble at 64,560 & tbl.7. After analyzing the cost increases of previous Clean Air Act regulations that courts had found to be reasonable, EPA concluded that the “capital cost impacts incurred under these prior standards are comparable in magnitude on an individual unit basis to those projected for the present standard.” *Id.* at 64,560. “The EPA has determined that the incremental capital costs of the final standard are reasonable because they are comparable to those in prior regulations and to industry experience, and because the fossil steam electric power industry has been shown to be able to successfully absorb capital costs of this magnitude in the past.” 2015 Preamble at 64,559/3; *see also id.* at 64,558/2 (“The EPA found that the anticipated cost impacts are similar to those in other promulgated NSPS—including for this industry—that have been upheld by the D.C. Circuit.”).

In the Proposed Rule, however, EPA reverses course and concludes that the exact same capital cost increase it previously calculated—21 to 22 percent—is “not reasonable.” Proposed Rule at 65,441/1. In contrast to its 2015 rulemaking, where EPA used DOE NETL studies to calculate specific capital costs with and without CCS,¹⁰⁶ in the Proposed Rule EPA does no new cost analysis and does nothing new to quantify capital costs. EPA now simply uses the same figures it looked at before and comes up with a completely different answer. EPA fails to provide a reasoned explanation for why it is changing its mind, given the absence of any new information. *See Brand X Internet Servs.*, 545 U.S. at 981 (stating that “unexplained inconsistency” in agency policy is “a reason for holding an interpretation to be an arbitrary and capricious change from agency practice.”).

¹⁰⁵ The LCOE also, by definition, incorporates capital costs. *See* 2015 Preamble at 64,560/2 (“While capital cost is a useful and relevant metric for capital-intensive fossil-steam units, the LCOE can serve as a useful complement because it takes into account all specified costs (operation and maintenance, fuel—as well as capital costs), over the whole lifetime of the project.”).

¹⁰⁶ *See* 2015 Preamble at 64,560 tbl.7 (listing capital costs in dollars per kilowatt).

EPA suggests a handful of ideas for reversing its position that the 21-to-22-percent increase in capital costs due to partial CCS is reasonable, Proposed Rule at 65,440/1-41/1, but none of them is a rational reason for the change, and it is not even clear why EPA mentions them. Although these ideas about capital costs are completely devoid of substance, they are the only rationale EPA provides for rejecting its previous economic analysis. *Id.* at 65,441/1 (“Based on these assessments, the EPA is proposing that the increase in capital costs due to partial CCS are not reasonable.”).

First, EPA points out that it is more expensive to build a coal-fired power plant now than it was in 1971 because of environmental controls that have been imposed over the ensuing five decades. Proposed Rule at 65,440/3. Then, EPA states that because it is now more expensive to build a coal-fired power plant than it was in 1971, “at the same percentage increase in capital costs, absolute costs are much higher.” *Id.* EPA fails to explain what new revelation it has derived from the obvious mathematical property that increasing a larger number by a given percentage will produce a larger result than increasing a smaller number by that same percentage. EPA then “notes” that the “absolute increase in capital costs” for a power plant to implement the Current Standard is larger than previous section 111(b) new source performance standards for these sources. *Id.* EPA was aware of this information previously, and it does not explain if, how, or why this would lead the agency to reverse its position that the cost of the Current Standard is reasonable. Further, EPA does not perform any calculation of this absolute increase in costs, nor does it consider to what degree inflation affects the relevance of comparing absolute cost changes. EPA also fails to explain why an absolute cost threshold is appropriate here or supported by the Clean Air Act or court precedent.

Second, EPA “notes” that previous NSPS rulemakings “generally concerned multiple pollutants and adopted multiple requirements based on multiple control technologies,” which makes it “more challenging” to compare these rulemakings with the “current rulemaking.” Proposed Rule at 65,440/3. EPA does not explain what conclusion it draws from it its greater challenge in comparing the Proposed Rule to these previous performance standards or how this has any bearing on its reversal of its position that capital cost of the Current Standard is reasonable. If EPA is unable to evaluate the capital cost of the Proposed Rule, as it suggests, it should not finalize it. To the extent that what EPA actually means is that it is “more challenging” to compare previous rulemakings with the Current Standard, it also fails to explain what is the result of its difficulty in making a comparison or why it discovered this difficulty for the first time in 2018. EPA also does not explain what the comparison is “more challenging” than. EPA’s statements about this “challenge” are simply nonsensical.

Finally, EPA alleges that “the fact that the utility industry was able to absorb 20 percent increases in cost due to pollution control in the past does not necessarily mean the industry could do so today.” Proposed Rule at 65,440/3. EPA supplies no evidence that this is true. Since in its new proposal EPA provides no quantitative analysis of the capital cost of complying with the Current Standard, the opposite conclusion—that the utility industry is now *better* able to absorb a 20-percent increase in cost—could just as easily be true. EPA cannot base its reversal of its 2015 economic analysis based on simple conclusory observations such as that the “utility sector is markedly different today.” *Id.* See *AEP Texas North Co. v. Surface Transp. Bd.*, 609 F.2d 432, 440-41 (D.C. Cir. 2010) (calling agency action arbitrary and capricious when agency relied on “generalized conclusions” and ignored evidence that the generalized conclusions might not hold in specific circumstances at issue).

Indeed, when EPA relied on an actual quantitative economic analysis in 2015, it rejected the same argument it now suggests requires it to change its mind. A commenter on the 2014 proposal claimed to EPA that the proposed standards “are the ‘straw that breaks the camel’s back’ and that EPA failed to also consider the costs of other pollution control standards for this industry.” EPA responded, “This is incorrect.” 2015 RTC, Response 6.3-281, at 6-190. “In assessing costs, the EPA relied on the NETL studies which assume a coal-burning steam generating unit in compliance with applicable environmental standards, including MATS for hazardous air pollution emissions, and the most recent NSPS for criteria pollutant emissions.” *Id.* Similarly, while EPA now suggests that coal-fired plants will not be able to pass on “higher operating costs” “without affecting coal-fired generation’s competitiveness with alternate forms of energy generation,” Proposed Rule at 65,441/1, EPA’s previous analysis found that no one would build a new coal-fired plant to be cost competitive in the first place. *See* section III.B.1, above; 2015 RTC, Response 3.3-3, at 3-70 (explaining that a new coal-fired plant would not be able to compete on price regardless of whether the Current Standard was in place).

EPA’s unsupported and unanalyzed reversal of its determination that the capital cost of partial CCS is reasonable is arbitrary and capricious and must be withdrawn. *See Fox*, 556 U.S. at 516 (stating that an agency must offer “a reasoned explanation . . . for disregarding facts and circumstances that underlay or were engendered by the prior policy”).

3. If EPA revises its analysis of the reasonableness of the cost of partial CCS, it should take into account offsets to that cost, including revenue from enhanced oil recovery and new 45Q tax credits. (C-28)

In conservatively finding the cost of partial CCS to be reasonable even without considering potential revenue streams, EPA’s cost analysis in the 2015 rulemaking was adequate and complied with the requirement in section 111(a) to take costs into consideration in determining the BSER. And, as discussed above, EPA’s new attempt in the Proposed Rule to reverse its previous determination by concluding that the cost is unreasonable is arbitrary and capricious. Nevertheless, if EPA does revise its analysis of the cost of employing partial CCS at a new coal-fired plant, it should take into account opportunities for the plant operator to offset that cost. Specifically, EPA should quantify the benefit to the plant operator from revenue from sale of captured CO₂, such as for enhanced oil recovery¹⁰⁷ (EOR), and from increased tax credits for CCS.

EPA described its cost calculations for the 2015 rulemaking as “conservative” in part because they did not include any offsetting sources of revenue.¹⁰⁸ In particular, EPA’s 2015 estimates did not “reflect revenues which can be generated by selling captured CO₂ for enhanced oil recovery,” 2015 Preamble at 64,563/2, nor did they include “grants or other benefits provided

¹⁰⁷ EPA describes enhanced oil recovery as “the injection of fluids into a reservoir after production yields have decreased from primary production in order to increase oil production efficiency.” 2015 Preamble at 64,566/1. “EOR has been successfully used at numerous production fields throughout the United States to increase oil recovery. The oil industry in the United States has over 40 years of experience with EOR. An oil industry study in 2014 identified more than 125 EOR projects in 98 fields in the United States.” *Id.* at 64,579/3.

¹⁰⁸ *See* footnote 92, above.

by federal or state governments” to defray the cost of CCS, *id.* at 64,564/2. If EPA decides to continue with its unnecessary and unsupported proposal to recalculate the cost of partial CCS to achieve a higher cost figure, it must include in its calculation the real-world opportunities to offset that cost.

First, EPA should include in any cost recalculation the revenue a plant operator would receive from EOR. EPA believes that “new units that capture CO₂ will likely be built in areas where there are opportunities to sell the captured CO₂ for some useful purpose prior to (or concomitant with) permanent storage. . . . In particular, the ability to sell captured CO₂ for use in enhanced oil recovery operations offers the most opportunity to reduce costs.” 2015 Preamble at 64,564/2. EPA explains that the “use of CO₂ for EOR can significantly lower the net cost of implementing CCS. The opportunity to sell the captured CO₂ for EOR, rather than paying directly for its long-term storage, improves the overall economics of the new generating unit.” *Id.* at 64,566. Since the 2015 rulemaking, EPA has determined that EOR is even more widely used than it previously thought. Proposed Rule at 65,441/3. Even in the Proposed Rule EPA acknowledges that if a plant owner sold captured CO₂, “variable operating costs could be reduced relative to an EGU without partial CCS and electric sales would be expected to increase, offsetting some of the control costs.” Proposed Rule at 65,440/1. Given that EPA considers EOR opportunities likely to reduce the cost of employing partial CCS, it should include EOR revenue in a future cost recalculation.

Second, newly expanded federal tax credits will help to offset the cost of partial CCS and should be incorporated into any future cost analysis EPA undertakes. The tax credits Congress expanded in 2018 in section 45Q of the Internal Revenue Code significantly reduce the cost of employing partial CCS.¹⁰⁹ Economic modeling performed this year by the Clean Air Task Force indicates that the 45Q credit will incentivize the storage of millions of tons of CO₂ annually.¹¹⁰ Because Congress designed this tax credit specifically to lower the cost of employing CCS, EPA should take those cost savings into account in any future analysis of BSER.

4. EPA fails to demonstrate that the cost of the Current Standard is unreasonable under the legal criteria EPA says govern its analysis: whether the cost of partial CCS is “exorbitant,” “greater than the industry could bear and survive,” or “excessive.”

Even if EPA’s revised cost calculations are accurate, they do not show that a developer of a new coal-fired power plant would find the cost of implementing partial CCS to be “exorbitant,” “greater than the industry could bear and survive,” or “excessive.” EPA does not even claim that they are, leaving the public to wonder what standard EPA is actually proposing to use to reverse the status quo. *See United Food v. NLRB*, 880 F.2d at 1436 (agencies “must accept responsibility for clarifying and identifying the standards that are guiding its decisions”).

¹⁰⁹ *See* Bipartisan Budget Act of 2018, H.R. 1892, § 41119. Pub. L. No. 115-123 (Feb. 9, 2018).

¹¹⁰ Clean Air Task Force, Carbon Capture & Storage in the United States Power Sector: The Impact of 45Q Federal Tax Credits (Feb. 2019), https://www.catf.us/wp-content/uploads/2019/02/CATF_CCS_United_States_Power_Sector.pdf.

EPA explained in the 2015 Preamble that “our determination that the costs are reasonable means that the costs meet the cost standard in the case law no matter how that standard is articulated, that is, whether the cost standard is articulated through the terms that the case law uses, *e.g.*, ‘exorbitant,’ ‘excessive,’ etc., or through the term we use for convenience, ‘reasonableness.’” 2015 Preamble at 64,559 n.255. EPA acknowledges that it continues to be bound by the same legal standard: when it determines that the cost of required emission reduction is “reasonable,” it means that the cost is “well within the bounds established by [D.C. Circuit] jurisprudence.” Proposed Rule at 65,433/2. And yet, even though EPA nowhere makes the finding that the cost is “exorbitant,” “greater than the industry could bear and survive,” or “excessive,” EPA concludes that the cost of meeting the Current Standard is not reasonable based on its new 2018 beliefs about preexisting cost figures. EPA has not, therefore, met its obligation to show an awareness that it is reversing its finding that the cost of the Current Standard comports with D.C. Circuit precedent and to provide a reasoned explanation for changing its previous determination that such costs are reasonable. *Fox*, 556 U.S. at 515. Furthermore, EPA’s failure to explain what criteria it is using to determine that the cost of the Current Standard is unreasonable violates the Clean Air Act’s rulemaking requirements. *See* 42 U.S.C. § 7607(d)(3) (requiring a proposed rulemaking to include “the major legal interpretations and policy considerations underlying the proposed rule”).

C. EPA lacks a reasonable basis for its proposed reversal of its determination that partial CCS is adequately demonstrated.

1. EPA’s suggestion that it no longer believes CCS is technically feasible defies overwhelming evidence, ignores precedent, and relies on new, baseless legal theories.

EPA’s previous determination that the technical feasibility of partial CCS is adequately demonstrated was based on extensive evidence and adhered to well-established precedent. EPA’s proposal to reverse that determination depends in large part on unacknowledged changes in the agency’s evaluation of the record and approach to determining BSER. Moreover, EPA’s BSER determination has been reconfirmed by the performance of partial CCS since 2015.

a. EPA’s 2015 determination was supported by extensive evidence and decades of precedent. (C-13)

EPA’s 2015 determination that the technical feasibility of partial CCS is adequately demonstrated was based on a mountain of evidence, as detailed in the 2015 Preamble at pages 64,548 through 64,558. First and foremost, EPA relied on SaskPower’s Boundary Dam project in Saskatchewan, Canada, a “commercial-scale fully integrated post-combustion CCS project at a coal-fired power plant.” 2015 Preamble at 64,549/2. EPA observed that the Boundary Dam facility

is capturing 90% of the unit’s CO₂ emissions using commercially available carbon capture technology The facility’s emissions are well below the 1,400 lb CO₂/MWh-gross standard [established by the rule]. Actually the emissions at the Boundary Dam facility must be below 1,400 lb CO₂/MWh as Canada’s emission standard is 0.42 tonnes CO₂/MWh, which is roughly equivalent to about 925 lb CO₂/MWh.

2015 RTC, Response 6.3-26, at 6-18. In addition, Boundary Dam, while selling some CO₂ for use in enhanced oil recovery, had also separately stored excess CO₂, fulfilling the “storage” aspect of CCS. *See* 2015 RTC, Response 6.3-85, at 6-53 (“Boundary Dam is in fact sequestering the excess CO₂ which it is not selling for EOR in a deep saline formation.”).

Moreover, Boundary Dam was not the only demonstration of the feasibility of partial CCS. As EPA noted in the preamble to its 2014 proposed rule, “capture of CO₂ from industrial gas streams has occurred since the 1930s, through use of a variety of approaches to separate CO₂ from other gases.”¹¹¹ In its February 2017 brief in *North Dakota v. EPA*, EPA summarized a number of other examples EPA had relied on in the 2015 rulemaking:

EPA also considered other coal-fired plants employing post-combustion capture technology, including AES Warrior Run in Cumberland, Maryland; Shady Point in Panama, Oklahoma; and Searles Valley Minerals in Trona, California. *Id.* at [80 Fed. Reg.] 64,550-51. Each of these plants has been operating for multiple years and employs the same carbon capture method on which EPA’s Best System determination is based—post-combustion amine scrubbing. *Id.*

These plants provide additional evidence that post-combustion carbon capture is adequately demonstrated. *Id.* These three plants capture slightly smaller amounts of CO₂ than the standard contemplates—up to nearly 80 percent of what a 500 MW plant meeting the standard by using partial CCS would capture. *Id.* at 64,574 (Table 12). Petitioners are incorrect, however, to suggest that EPA “presented no evidence” that these projects “could be scaled up to commercial-scale units while being reasonably reliable, efficient, and not unreasonably costly.” Non-State Br. 34. On the contrary, the record is replete with information explaining how small- or pilot-scale carbon capture systems could be successfully scaled up. 80 Fed. Reg. at 64,550, 64,557; RTC 6.3-23, 6.3-44. Notably, much of this detailed how-to comes from studies by steam electric utilities. 80 Fed. Reg. at 64,557 (discussing studies by American Electric Power and Tenaska Trailblazer Partners); *see also* RTC – Chapter 2, 2.1-37, EPA-HQ-OAR-2013-0495-11861.

Respondent EPA’s Brief (ECF #1659737), at 26-27, *North Dakota v. EPA*, No. 15-1381 (D.C. Cir. Feb. 6, 2017) (joint appendix citations omitted) (attached hereto as Exhibit C).

EPA also noted in the 2015 Preamble that American Electric Power (AEP) and Alstom Power conducted a “pilot-scale demonstration at [AEP’s] Mountaineer Plant in West Virginia,” which “achieved capture rates from 75 percent . . . to as high as 90 percent.” 2015 Preamble at 64,552/1. EPA further observed that “AEP also proposed a Front End Engineering & Design (FEED) Report, explaining how its pilot-scale work could be scaled up to successful full-scale operation . . .” *Id.* at 64,552/1-2. EPA noted that high-ranking executives of both AEP and Alstom concluded that the pilot demonstrated the feasibility of CCS. It quoted Mike Morris, the Chairman and CEO of AEP, as saying in 2011: “we feel that we have demonstrated to a certainty that the carbon capture and storage is in fact viable technology for the United States and quite

¹¹¹ Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, Proposed Rule, 79 Fed. Reg. 1,430, 1,471/3 (proposed Jan. 8, 2014).

honestly for the rest of the world going forward.” *Id.* at 64,556/1.¹¹² And it quoted Alstom’s senior Vice President Joan McNaughton as saying: “[t]he Validation Plant at Mountaineer demonstrated the ability to capture up to 90% of the carbon dioxide from a stream of the plant’s emissions. The technology works” 2015 RTC, Response 6.3-107, at 6-69.

In the 2015 Preamble, EPA also cited the Southern Company/MHI Plant Barry demonstration project in Alabama, which achieved a “CO₂ capture rate of over 90 percent,” transported the captured CO₂, and injected it into a saline reservoir for storage. 2015 Preamble at 64,552/2. It also cited vendors’ performance guarantees for CCS technology, noting that the D.C. Circuit Court has relied on vendor guarantees and expectations as confirmation of technical feasibility. *Id.* at 64,555/1 (citing *Sierra Club v. Costle*, 657 F.2d at 364, and *Essex Chemical v. Ruckelshaus*, 486 F.2d 427 (D.C. Cir. 1973)).

The record before EPA makes CCS more “adequately demonstrated” than other technologies previously approved as BSER by EPA and the courts.¹¹³ In *Sierra Club v. Costle*, in evaluating EPA’s choice of flue gas desulfurization (FGD) scrubbing technology as BSER, the Court characterized EPA’s data on the prior performance of the technology as “evidence that only one commercial scale plant and one small pilot unit can almost but not quite meet the standard.” 657 F.2d at 363. But the Court upheld EPA’s choice based on its acceptance of “EPA’s documentation on the potential for improved performance of scrubbers to achieve [the standard].” *Id.* at 364. In *Lignite Energy Council v. EPA*, 198 F.3d at 933-34, the court held that EPA reasonably set a performance standard for coal-fired industrial boilers by extrapolating from the performance of technology used on utility boilers. The absence of data for industrial boilers was “not surprising” because of the newness of the technology; as such, EPA could compensate for the lack of data by using other qualitative methods, “including the reasonable extrapolation of a technology’s performance in other industries.” *Id.* at 934.

And in *Essex Chemical v. Ruckelshaus*, 486 F.2d 427, the court upheld an EPA rule requiring that sulfuric acid plants meet an emissions standard of 4 pounds per ton by using “dual absorption” technology, although prior tests showed that the technology had an inconsistent track

¹¹²AEP subsequently took the position that the Mountaineer project did not adequately demonstrate that partial CCS could be adopted at commercial scale. Comments of AEP, 80-83 (May 8, 2014), Docket ID EPA-HQ-OAR-2013-0495-10618. As EPA noted in the 2016 Reconsideration Denial, “EPA responded to all of those comments, noting among other things that both AEP’s own FEED study and the NETL studies set out in point-by-point, system-by-system detail how the capture technology could be scaled up to full-scale, why the costs at the project were not indicative of costs at a new facility (for example, since the project was a retrofit, the project presented siting issues (including siting for monitoring wells) that could be avoided for a new plant), and generally why partial CCS is not exorbitantly costly.” 2016 Reconsideration Denial, at 31 (citing 2015 RTC, Responses 6.3-23, 6.3-93, 6.3-247, 6.3-257, and 6.3-272).

¹¹³ EPA itself made this point in response to comments on the proposed rule. “CCS is actually further developed than were FGD scrubbers when selected as BSER in the 1971 NSPS for the same industry.” 2015 RTC, Response 6.3-17, at 6-14.

record of meeting that standard. Tests at one plant showed that “the average of the nineteen readings taken when the plant was near full capacity is approximately 4.6 lbs./ton. In sum, the proposed standard was exceeded on two occasions, equalled on another, and nearly equalled on the average of nineteen different readings.” *Id.* at 437. And yet the Court concluded: “Keeping in mind Congress’ intent that new plants be controlled to the ‘maximum practicable degree,’ we find that the 4.0 lbs./ton standard based on a dual absorption system for new elemental sulfur burning plants is the result of the exercise of reasoned discretion by the Administrator and cannot be upset by this court.” *Id.*

It is hard to overstate what a drastic departure from precedent it would be for EPA to conclude, based on this record, that CCS is not technically feasible. Rejecting CCS and adopting a less effective technology as BSER would wholly disregard Congress’s intent that “new plants be controlled to the ‘maximum practicable degree.’” *Id.*

b. EPA’s proposal fails to acknowledge the ways it is inconsistent with EPA’s previous positions. (C-10)

Historically, both EPA and the courts have taken the position that a technology can be considered “adequately demonstrated” for purposes of section 111 even if the technology has not yet actually been used to meet the adopted standard. “Recognizing that the Clean Air Act is a technology-forcing statute,” the D.C. Circuit Court in *Sierra Club v. Costle* upheld EPA’s “authority to hold the industry to a standard of improved design and operational advances, so long as there is substantial evidence that such improvements are feasible and will produce the improved performance necessary to meet the standard.” 657 F.2d at 364. “Section 111 looks toward what may fairly be projected for the regulated future, rather than the state of the art at present.” *Portland Cement Ass’n v. Ruckelshaus*, 486 F.2d at 391.

EPA fails to contend with these precedents or acknowledge that it is departing from its long-held positions following them. This in itself renders EPA’s proposed action arbitrary and capricious. *Fox*, 556 U.S. at 515 (“[T]he requirement that an agency provide reasoned explanation for its action would ordinarily demand that it display awareness that it *is* changing position.”).

For instance, despite acknowledging that CCS is currently operating at Boundary Dam, EPA “requests comment on whether Boundary Dam’s first-year operational problems cast doubt on the technical feasibility of fully integrated CCS (Comment C–10).” Proposed Rule at 65,444/2. In other words, although the technology underlying the BSER is feasible now and “may fairly be projected for the regulated future,” EPA suggests the fact that partial CCS has encountered some problem in the past means it is not adequately demonstrated. This backwards-looking approach to BSER is inconsistent with D.C. Circuit precedent and longstanding EPA practice, but EPA fails to address or even acknowledge that inconsistency.

Nor does EPA acknowledge that EPA itself has thoroughly refuted the argument that “Boundary Dam’s first-year operational problems cast doubt on the technical feasibility of fully integrated CCS.” In its 2016 Reconsideration Denial, EPA referred to this argument as “greatly exaggerated and essentially incorrect.” EPA said:

[T]he CO₂ capture system at BD3 is operating successfully, the unit meets the Canadian performance standard for CO₂ emissions (which is more stringent than the U.S. standard), and it is producing more CO₂ for enhanced oil recovery than

called for by contract. Operational issues in the first year of operation were related largely to ancillary systems and not to the carbon capture system, and appear to have been successfully resolved.

2016 Reconsideration Denial, at 7. EPA went on to explain in detail why the first year operational issues did not undermine the conclusion that CCS is technically feasible:

It is not unusual for plants to experience operational issues after first installing and operating a complex technical system. See, e.g., 79 FR 1482. However, according to SaskPower, most of the technical issues experienced by the unit in its initial year of operation involved ancillary equipment and control systems rather than technical issues that are directly attributable to the carbon capture system itself. For example, there were idiosyncratic issues associated with the design or misplacement of ordinary components – such as exhaust valves being installed too near intake valves. There was also a delay associated with the need to install a new, larger storage tank for the amine solvent and then to fix the tank, which the company described as being delivered with visible hairline cracks in the tank floor. In addition, in the initial months of operation, the unit experienced some operational difficulties associated with SaskPower’s ability to control the amine regeneration temperature because of a leaky steam valve. This resulted in overheating and subsequent degradation of the amine solvent. While the leaky steam valve resulted in an overall degradation of the performance of the carbon capture system, few would characterize steam valve technology as “not adequately demonstrated” or “first-of-a-kind”. Nor is a cracked storage tank the type of development that raises issues regarding the feasibility of carbon capture technology.

2016 Reconsideration Denial, at 8. EPA then observed that even with its first-year operational problems, Boundary Dam was meeting the standard set by the 2015 Preamble:

Over the one-year operating period from October 2014 through September 2015, even considering the facility downtime, BD3 captured approximately 415,000 tons of CO₂. This is a capture rate exceeding 40 percent, which is significantly more efficient than the 12-month annual capture rate (reflecting partial carbon capture at an annual rate of approximately 16 to 23 percent depending on coal type) on which the section 111(b) new source standard is predicated. See 80 FR 64573-74. Indeed, the plant’s capture amount would have comfortably satisfied the standard for a plant with five times the volume of CO₂ emissions (i.e., a 500 MW SCPC plant). From February 2015 through January 2016, the plant captured 625,000 tons of CO₂, a capture rate exceeding 60 percent, which is, as noted, well in excess of what the NSPS requires (notwithstanding downtime for the system in June, September, and October). The initial capture rates for the months immediately following the two month maintenance period also greatly exceed those on which the NSPS are predicated, as does the plant’s projected 2016 capture rate. Equally important is that the plant’s initial operational issues appear to be resolved, and that most of these operational issues were related, in any case, to ancillary systems at the plant, not to the carbon capture system.

2016 Reconsideration Denial, at 9-10.

EPA cannot reverse its position on the conclusions to be drawn from Boundary Dam's first year of operation without explaining why it has determined that its previous position was wrong. "[A] reasoned explanation is needed for disregarding facts and circumstances that underlay or were engendered by the prior policy." *Fox*, 556 U.S. at 516.

c. Boundary Dam's and Petra Nova's most recent performance, along with numerous other examples of the successful operation of CCS, and the Department of Energy's continuing embrace of CCS technology, further demonstrate the technical feasibility of CCS. (C-13)

As noted above, EPA concluded in 2016 that Boundary Dam's performance demonstrated the feasibility of CCS. Boundary Dam's more recent performance reaffirms that conclusion. SaskPower issues monthly reports on the progress of the Boundary Dam project. Its report for December 2018 states:

The Carbon Capture and Storage (CCS) facility at Boundary Dam Power Station captured 70,395 tonnes of CO₂ in December, which is the equivalent of taking 17,599 vehicles off the road. The facility was online 86.3 per cent of the month coming offline for 102 hours due to a boiler tube leak on Boundary Dam Unit 3. The CCS facility achieved a high capture rate including a peak one-day capture rate of 2,807 tonnes.

In 2018, the CCS facility captured a total of 625,996 tonnes—a vast improvement compared to the previous year. The overall availability of the facility in 2018 was 69 per cent. However, if you exclude the days when the CCS facility was available but offline because of issues at the power plant (for example – the days when the power plant was down due to storm damage this summer) that increases to 94 per cent availability. This positive result can be attributed to the improvements made during the 2017 planned maintenance outage. Amine usage for 2018 was also lower compared to previous years.¹¹⁴

Further recent proof of the feasibility of CCS is provided by the success of the Petra Nova project near Houston, Texas. In March 2018, EPA prepared a memorandum on the status of the CCS projects referenced in the 2015 rulemaking.¹¹⁵ This CCS Status Memorandum described an article written by the Department of Energy in October 2017, regarding the Petra Nova project, "reported to be the world's largest post-combustion carbon capture system":

¹¹⁴ SaskPower, *BD3 Status Update: December 2018* (Jan. 11, 2019), <https://www.saskpower.com/about-us/our-company/blog/bd3-status-update-december-2018>.

¹¹⁵ U.S. EPA, Memorandum, Review of the current status of the Carbon Capture and Sequestration projects referenced in the Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units 2015 rulemaking (Mar. 2018), Docket ID EPA-HQ-OAR-2013-0495-11947 (CCS Status Memorandum).

The Petra Nova project reached a major milestone, capturing more than 1 million tons of CO₂ for use in enhanced oil recovery (EOR). The project has been successfully demonstrating an advanced amine-based CO₂-capture technology that removes 90 percent of the CO₂ emitted from a flue gas stream. The project began commercial operations on January 10, 2017. On April 13, 2017 Secretary of Energy Rick Perry attended a ribbon cutting ceremony for the project, where he noted that Petra Nova “demonstrates that clean coal technologies can have a meaningful and positive impact on the Nation’s energy security and economic growth.”

CCS Status Memorandum, at 21-22.¹¹⁶ The project was built on time and on budget¹¹⁷ and is capturing 4,776 MT/day.¹¹⁸

EPA now suggests that the performance of Petra Nova is irrelevant, because “it has not demonstrated that the integration of the thermal load of the capture technology into the EU steam generating unit (*i.e.*, boiler) steam cycle. Rather, the parasitic electrical and steam load are supplied by a new 75 MW co-located natural gas fired facility.” Proposed Rule at 65,444/2. But this in no way undermines EPA’s previous conclusion that Petra Nova is evidence of the feasibility of CCS.¹¹⁹ The question of how the “parasitic and electrical steam load” is supplied is separate from the question of whether a facility is successfully demonstrating carbon capture and storage as an effective system of emissions reduction. A group of experts who evaluated the different technologies employed at Boundary Dam and Petra Nova concluded that a Petra Nova-style plant could capture 65.6 percent of emissions.¹²⁰ EPA determined that a carbon capture rate of just 16 percent (for a facility burning bituminous coal) or 23 percent (for a facility burning subbituminous coal or dry lignite) will be sufficient to meet the Current Standard. 2015 Preamble

¹¹⁶ See U.S. Dep’t of Energy, Office of Fossil Energy, *DOE-Supported Petra Nova Captures More Than 1 Million Tons of CO₂*, Oct. 23, 2017, <https://www.energy.gov/fe/articles/doe-supported-petra-nova-captures-more-1-million-tons-co2>.

¹¹⁷ David Greeson, NRG, PowerPoint, “What Do Updated 45Q Tax Credits Mean for Carbon Capture,” (Apr. 10, 2018), https://www.naruc.org/default/assets/File/CCS45Q_041018.pdf.

¹¹⁸ Sonal Patel, “Japanese Conglomerates Rejigger Power Sector Strategies,” *Power* (Feb. 21, 2019), <https://www.powermag.com/japanese-conglomerates-rejigger-power-sector-strategies/?pagenum=3>.

¹¹⁹ EPA cited Petra Nova both in the 2015 Preamble at pages 64,551-52 and at page 4 of “Appendix 3 — Non-BSER CPP Flexibilities,” an appendix to the January 11, 2017 “Basis for Denial of Petitions to Reconsider and Petitions to Stay the CAA section 111(d) Emission Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Utility Generating Units,” Docket ID EPA-HQ-OAR-2013-0602-37338 (also submitted as Attachment J to Docket ID EPA-HQ-OAR-2017-0355-24423).

¹²⁰ H. Mantripragada, H. Zhai and E. Rubin, *Boundary Dam or Petra Nova – Which is a better model for CCS energy supply?*, *International Journal of Greenhouse Gas Control*, Mar. 2019, at 63.

at 64,513/2-3. If a Petra Nova-style system can meet the 2015 standard, it is clearly a better “system of emissions reduction” than the “system” EPA is currently proposing to meet a weaker standard.

The experts who recently compared Boundary Dam and Petra Nova also concluded that “under most design . . . market . . . and policy . . . scenarios, using an advanced gas-fired combined cycle co-generation plant to supply CCS regeneration steam and electricity has both performance and cost benefits compared to the case where steam and electricity are supplied from the primary power plant steam cycle.” *Id.* at 66. EPA’s newfound disdain for the Petra Nova model is unsupported and arbitrary.¹²¹

EPA recently received an updated and extensive list of numerous other examples of the successful operation of carbon capture and storage, in comments submitted by the Natural Resources Defense Council and the Clean Air Task Force on the proposal to replace the Clean Power Plan.¹²²

The Department of Energy’s conclusion that CCS is technically feasible is also compelling. The Department of Energy has endorsed the feasibility of CCS, not only in the context of Petra Nova, but repeatedly for the power industry as a whole. A January 29, 2019, *E&E News* article reported:

The United States is “more involved than ever” in carbon capture technologies and intends to announce funding in the coming months to support two commercial-scale systems that could be used on gas and coal plants, a senior Department of Energy official said yesterday.

Speaking at the Atlantic Council in Washington, D.C., DOE Assistant Secretary of Fossil Energy Steven Winberg said the not-yet-released funding announcement would support at least two front-end engineering design (FEED) studies for

¹²¹ Even if one accepted the idea that “integration of the thermal load” is an essential aspect of a CCS system, EPA has already rejected the idea that “a system cannot be adequately demonstrated unless all of its component parts are operating together. Courts have, in fact, accepted that EPA can legitimately infer that a technology is demonstrated as a whole based on operation of component parts which have not, as yet, been fully integrated.” 2015 Preamble at 64,556/3 (citing *Sur Contra la Contaminacion v. EPA*, 202 F.3d 443, 448 (1st Cir. 2000); *Native Village of Point Hope v. Salazar*, 680 F.3d 1123, 1133). Once again, EPA is reversing its previous position without even demonstrating awareness that it is changing position, let alone explaining the change. *Fox*, 556 U.S. at 515 (“[T]he requirement that an agency provide reasoned explanation for its action would ordinarily demand that it display awareness that it is changing position.”).

¹²² Natural Resources Defense Council and Clean Air Task Force, Comment, Re: Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revision to New Source Review Program, 83 Fed. Reg. 44,746 (Aug. 31, 2018), (Oct. 31, 2018), Docket ID EPA-HQ-OAR-2017-0355-24266; see appendix B thereto.

commercial-scale carbon capture, utilization and storage (CCUS). There would be additional funding announcements from DOE to support “transformational” technologies that can provide real-time sensing of carbon dioxide below the Earth’s surface, he said.

“The United States will remain a strong global voice for CCS,” Winberg said. “I expect that we will be more involved than ever . . . and develop and broadly deploy these critical technologies.” . . .

He said there needed to be more “robust” policies supporting the technology, adding officials were “excited” about the upcoming Clean Energy Ministerial, an international forum of energy leaders.¹²³

As the Supreme Court stated in *State Farm*, an agency action is “arbitrary and capricious if the agency . . . entirely failed to consider an important aspect of the problem, [or] offered an explanation for its decision that runs counter to the evidence before the agency.” *State Farm*, 463 U.S. at 43. Given the Department of Energy’s expertise on energy technology, its embrace of the feasibility of CCS, which EPA is undoubtedly aware of, is important “evidence before the agency,” which EPA must address.

d. EPA’s suggestion that projects receiving public funds cannot provide evidence of technical feasibility unless industry is already voluntarily using that technology commercially has no basis in the statute. (C-11)

Another EPA rationale for questioning the technical feasibility of CCS has no actual relationship to technical feasibility at all. EPA states: “Because no independent commercial CCS projects are in operation, EPA solicits comments on whether the fact that Boundary Dam and Petra Nova were dependent on government support casts doubt on the technical feasibility of CCS, e.g., whether it raises concerns as to the extent to which developers are willing to accept the risks associated with the operation and long-term reliability of CCS technology.” Proposed Rule at 65,444/2.

EPA addressed the argument about government support in the 2015 Preamble, making the obvious point that “the availability of – or the lack of – external financial assistance does not affect the technical feasibility of the technology.” 2015 Preamble at 64,550/2. EPA further observed, in the context of its discussion of cost:

The need for subsidies to support emerging energy systems and new control technologies is not unusual. Each of the major types of energy used to generate electricity has been or is currently being supported by some type of government subsidy such as tax benefits, loan guarantees, low-cost leases, or direct expenditures for some aspect of development and utilization, ranging from exploration to control installation. This is true for fossil fuel-fired, as well as

¹²³ Christa Marshall, *DOE to fund ‘transformational’ projects*, E&E News, Jan. 29, 2019, <https://www.eenews.net/energywire/stories/1060118817>.

nuclear-, geothermal-, wind-, and solar-generated electricity. As stated earlier, the EPA considers the costs of partial CCS at a level to meet the final standard of performance to be reasonable even without considering these opportunities to further reduce implementation and compliance costs.

2015 Preamble at 64,564/2. EPA addressed the argument again just two years ago in its brief in *North Dakota v. EPA*:

Finally, the fact that Boundary Dam was partially subsidized by the Canadian government does not render it inappropriate to support the determination that the carbon capture technology it utilizes is adequately demonstrated. Non-State Br. 31. Nothing in the text of Section 111(a)(1) or this Court’s jurisprudence suggests that such subsidies automatically disqualify a plant’s operational experience from consideration in determining the Best System.¹²⁴

EPA now fails to acknowledge or explain its apparent change of position, as it is required to do. *See Fox*, 556 U.S. at 515.

EPA’s new interpretation is contrary to Congress’s intent to limit harmful emissions from new sources to the maximum possible degree and to encourage the development and deployment of new technology. Given the ubiquity of subsidies from federal and state governments, this interpretation could extend well beyond this rulemaking to hamstring EPA’s ability to use section 111 to achieve emission reductions from new and existing sources. For example, municipal solid waste landfills—often owned by public entities—have historically received a variety of state tax credits and other incentives to capture methane and other gases, leading to controls that have long formed the basis of the best system of emissions reduction for that source category. Moreover, EPA’s new interpretation would limit the benefits of state efforts to support emerging control measures, thus reducing opportunities for federal action to amplify the benefits of successful state innovation. For example, state efforts to achieve greater use of CCS through tax exemptions and financial assistance can lead to much greater climate benefits if those technologies ultimately inform nationwide standards. Adopting the position that the existence of public support for a technology is evidence that the technology is not technically feasible would diminish the value of—and potentially discourage—these state efforts. EPA provides no reason to believe that Congress intended this perverse result.

EPA’s statement that the absence of “independent commercial CCS projects” is an indication of non-feasibility could have far-reaching implications that go beyond the question of whether or how to factor in the issue of government support for prior projects. A position that the only technologies that can be considered adequately demonstrated are the ones that the regulated industry has developed on its own solely due to market forces is contrary to EPA’s own 2018 analysis of the need for regulation of CO₂ emissions:

Many regulations are promulgated to correct market failures, which otherwise lead to a suboptimal allocation of resources within the free market. Air quality and pollution control regulations address “negative externalities” whereby the

¹²⁴ Respondent EPA’s Brief (ECF #1659737) at 25, *North Dakota v. EPA*, No. 15-1381 (D.C. Cir. Feb. 6, 2017).

market does not internalize the full opportunity cost of production borne by society as public goods such as air quality are unpriced.

While recognizing that optimal social level of pollution may not be zero, GHG emissions impose costs on society, such as negative health and welfare impacts, that are not reflected in the market price of the goods produced through the polluting process. For this regulatory action the good produced is electricity. If a fossil fuel-fired electricity producer pollutes the atmosphere when it generates electricity, this cost will be borne not by the polluting firm but by society as a whole, thus the producer is imposing a negative externality, or a social cost of emissions. The equilibrium market price of electricity may fail to incorporate the full opportunity cost to society of generating electricity. Consequently, absent a regulation on emissions, the EGUs will not internalize the social cost of emissions and social costs will be higher as a result.

2018 Economic Impact Analysis, at 1-2.

Such a position would also contradict EPA's statement in the 2015 Preamble that "[t]here is no requirement, as part of the BSER determination, that the EPA finds that the technology is 'commercially available.'" 2015 Preamble at 64,556/2. Indeed, the suggestion that a technology cannot be considered technically feasible unless the industry has already adopted it as a result of market forces runs counter to the whole idea that "Section 111 looks toward what may fairly be projected for the regulated future, rather than the state of the art at present." *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d at 391. And it would undermine the intent of Congress in enacting section 111(b) that "new plants be controlled to the 'maximum possible degree.'" *Essex Chemical*, 486 F.2d at 437.

In fact, consistent with EPA's own economic understanding quoted above, a major reason industry actors have not launched more commercial CCS projects may be the *absence of regulation*. In the 2014 proposed rule, EPA said:

In 2011, AEP deferred construction of a large-scale CCS retrofit demonstration project on one of their coal-fired power plants because the state's utility regulators would not approve cost recovery for CCS investments without a regulatory requirement to reduce CO₂ emissions.

79 Fed. Reg. at 1,469/1. EPA elaborated on this point in the 2015 Preamble, saying:

[W]e note that the Administration's CCS Task Force report recognized that CCS would not become more widely available without the advent of a regulatory framework that promoted CCS or provided a strong price signal for CO₂. In this regard, we note American Electric Power's statements regarding the need for federal requirement for GHG control to aid in cost recovery for CCS projects, to attract other investment partners, and thereby promote advancement and deployment of CCS technology: "as a regulated utility, it is impossible to gain regulatory approval to recover our share of the costs for validating and deploying the technology without federal requirements to reduce greenhouse gas emissions already in place. The uncertainty also makes it difficult to attract partners to help fund the industry's share."

2015 Preamble at 64,572 (quoting a July 14, 2011 AEP press release). Making the same point in its 2015 Responses to Comments, EPA cited a similar statement by AEP's partner Alstom:

"AEP's decision to put Mountaineer II on-hold (sic) is a bellwether to our leaders on the consequences of uncertain climate policy. The Validation Plant at Mountaineer demonstrated the ability to capture up to 90% of the carbon dioxide from a stream of the plant's emissions. The technology works. But without clear policies in place outlining options for cost recovery, power generators are hard pressed to invest in its continued refinement."

2015 RTC, Response 6.3-107, at 6-69.

Thus, EPA's suggestion that the rarity of 100-percent privately funded commercial CCS projects is a reason to reject CCS as BSER is contradicted by industry actors' own statements. Rather, adopting CCS as BSER may be a step needed to generate more private commercial investment in CCS.

As the Supreme Court has instructed, "a reasoned explanation is needed for disregarding facts and circumstances that underlay or were engendered by the prior policy." *Fox*, 556 U.S. at 516. The evidence that regulation is needed to *promote* commercial adoption was among the "facts and circumstances" that underlay the Current Standard. But now, EPA fails to even acknowledge that evidence and its previous conclusion, let alone provide a reasoned explanation for disregarding them.

2. The proposed weakening of BSER cannot be supported on the theory that it would drive technological adoption in other countries.

As noted above, courts have previously explained what it means to say the Clean Air Act is a "technology-forcing" statute: EPA can "hold the industry to a standard of improved design and operational advances." *Sierra Club v. Costle*, 657 F.2d at 364. EPA does acknowledge that it is required to "consider the effect of its selection of BSER on technological innovation or development." Proposed Rule at 65,448/2. But EPA's own statements make it clear that its Proposed Rule will not force any technological innovation.

Specifically, EPA acknowledges that any new coal-fired plant built in the United States would already meet the proposed standard anyway because, even without the Proposed Rule, a developer would use compliant technology. 2018 Economic Impact Analysis, at 3-5 ("modeling demonstrates that all new sources covered by this proposal that are currently planned or projected to be constructed are capable of meeting the proposed standard without taking any additional action"). Thus, if finalized, the Proposed Rule would not compel or even encourage the developers of new coal-fired power in the U.S. to do anything at all.

EPA nonetheless suggests, nonsensically, that the proposed rule would improve technology in other countries. In conclusory fashion, EPA says that "establishing [the proposed BSER] as the basis for control requirements in the U.S. for new and reconstructed sources would help establish it in other nations, resulting in a reduction in global CO₂ emissions." Proposed Rule at 65,448/3. EPA provides no evidence to support these statements. Since new coal-fired plants will use technology complying with this Proposed Rule regardless of whether the rule exists, it is illogical for EPA to conclude that it is the rule itself that will affect other nations, let alone "force" the adoption of technology in those countries or "hold" industry in those countries to any standard at all. Further, EPA supplies no evidence that global CO₂ emissions will be

reduced if the rule is finalized. In fact, EPA's only analysis is directly to the contrary. It claims that under the Proposed Rule, if a new coal-fired plant is built, CO₂ emissions will increase, but EPA is unwilling to try to quantify them:

To the extent that new coal-fired facilities are constructed, a BSER coal facility under the proposed standard would have higher CO₂ emissions than a BSER facility under the 2015 final standards. We do not attempt to quantify the impacts of these increased emissions or economic value of these impacts.

2018 Economic Impact Analysis, at 2-6.

And, once again, EPA is completely ignoring its own prior conclusion that requirements like those in the Proposed Rule are *not* technology forcing. In 2014, EPA explained:

Identifying highly efficient generation technology as the BSER would not achieve another purpose of CAA section 111, to encourage the development and implementation of control technology. At present, CCS technologies are the most promising options to achieve significant reductions in CO₂ emissions from fossil-fuel boilers and IGCC units. A standard based on the performance of highly efficient coal-fired generation does not advance the development and implementation of control technologies that reduce CO₂ emissions.

79 Fed. Reg. at 1,468-69. EPA has failed to properly consider the effect of the rule on technological innovation and development, as required in a section 111 rulemaking, and EPA's proposed rationale for weakening the current standard is illogical and unsupported. *State Farm*, 463 U.S. at 43 (requiring an agency to "examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made").

3. The actions of 32 states support a finding that CCS technology is adequately demonstrated.

A majority of states recognize that CCS is a demonstrated system of emissions reduction or that CCS adds value to businesses, or both. For example, the Oklahoma Legislature has declared, "Storage of carbon dioxide in geological formations is an effective and feasible strategy to deposit, store or sequester large volumes of carbon dioxide over long periods of time," while Kentucky identifies CCS as an "economic development priority" that "will create jobs . . . and favorably position the Commonwealth for future leadership and growth in the field."¹²⁵ Starting as early as 1999, 32 states have enacted statutes or adopted regulations to support and promote local use of CCS technology.¹²⁶

- Eighteen states have established permitting and monitoring rules and procedures for CCS components, including injection wells and CO₂ pipelines. Pipelines to carry carbon dioxide to EOR operations or geologic storage sites have existed since Texas oil fields

¹²⁵ Okla. Stat. tit. 27A, § 3-5-101(B)(6) (emphasis added); Ky. Rev. Stat. Ann. § 353.802(5).

¹²⁶ See "Carbon Sequestration in State Statutes and Regulations," attached hereto as Appendix B. The following breakdown summarizes the detail in Appendix B.

piloted EOR in 1972,¹²⁷ and regulatory frameworks supporting such pipelines are almost as old.¹²⁸ Many state laws build upon federal regulations for Class VI underground injection wells (i.e., injection wells exclusively for geologic CO₂ storage) in 40 C.F.R. Parts 144 and 146.¹²⁹ In short, 18 states have put regulatory frameworks in place to manage the use of CCS in their jurisdictions. These actions underscore that CCS is either in use or fully anticipated in these states.

- Twelve states recognize power plants using CCS as renewable energy resources and/or make plants with CCS eligible for credit under a state renewable portfolio standard. In doing so, these states prioritize CCS over other fossil-fueled generation, indicating that many states have concluded that power plants with CCS are safe, reliable and affordable sources of power.
- Similarly, eight states expressly allow utilities deploying CCS to recover their costs from ratepayers through service surcharges. Because utility regulators must ensure ratepayers only pay for prudent investments and are charged reasonable electricity rates, in effect, these states have concluded CCS is adequately demonstrated and reasonably cost-effective.
- Fifteen states provide financial incentives for CCS projects, including research grants, tax credits or deductions for facilities and equipment, and even outright waivers of property or sales taxes. Five such states have targeted these incentives to encourage the construction of new CCS facilities or pipelines, and three have directly invested public dollars in building CCS projects. In all cases, the public money dedicated to attracting or facilitating CCS projects in their state again underscores the demonstrated economic and environmental benefits of widespread CCS.

Many of the states' CCS laws indicate the CO₂ emissions limit that EPA adopted in 2015, 1,400 lb CO₂/MWh, is achievable with adequately demonstrated technology or methods. Two states use a lower benchmark—1,100 lb CO₂/MWh—to qualify power plants to recover CCS

¹²⁷ Expanding & Accelerating the Deployment & Use of Carbon Capture, Utilization, and Sequestration, Hearings before Sen. Comm. on Envir. & Public Works, 115th Cong., 1st Sess., 74 (2017), <https://www.govinfo.gov/content/pkg/CHRG-115shrg27318/pdf/CHRG-115shrg27318.pdf> (CCS Sen. Hrg.); see Western Gov. Ass'n Policy Res. 2015-06, "Enhanced Oil Recovery," ¶1, *id.* at 21-23.

¹²⁸ See Miss. Code Ann. § 11-27-47 (1984); N.D. Cent. Code § 57-06-17.1 (1991) (amended 1997).

¹²⁹ Ill. Admin. Code tit. 35, § 730, subpart H; Mich. Admin. Code r. 299.9204; N.D. Admin. Code 43-05-01-01; Ohio Admin. Code r. 3745-51-04(H); Tenn. Comp. R. & Regs. 0400-12-01-.02; Utah Admin. Code r. R315-261-1; Vermont Admin. Code r. 16-3-303:11-201; Wyo. R. & Regs. 020.0011.24. North Dakota's regulations and its "Carbon Dioxide and Underground Storage" statutes formed the basis of EPA's approval in April 2018 of its state-administered Class VI underground injection control program. 83 Fed. Reg. 17,758, 17,761 (Apr. 24, 2018).

costs through rates,¹³⁰ to receive tax credits,¹³¹ or to operate at all.¹³² Similarly, six states require power plants to capture a certain percentage of CO₂ emissions to receive tax incentives, recover costs, or operate: North Dakota (20 to 80 percent), Montana (50 percent), Texas (70 percent), Michigan (85 percent), and Kansas and Minnesota (100 percent).¹³³ Compared to these capture rate requirements, the 16-to-23-percent partial CCS rate assumed in the Current Standard is conservative.

The number of states adopting laws on CCS has only grown since the 2015 rulemaking, reflecting the global recognition that CCS can be an important technology for limiting CO₂ emissions as part of a climate change mitigation strategy.¹³⁴ In this sense, EPA's failure to encourage the state of the art in CCS disservices American utility companies in the long run, as their international counterparts take the lead in advancing promising technology. As the Chairman of the U.S. Senate's Environment and Public Works Committee remarked in 2017, "America is currently a leader in [CCS] technology, and we want to keep it that way."¹³⁵ Senator Barrasso continued:

Encouraging American innovation is the right approach to continuing American leadership, leadership in the development of technologies to lower the emissions associated with fossil fuel use. Through American leadership we create opportunities to export our innovations around the world. . . . Now is the time to see what more we could do to encourage and remove impediments to the use and deployment of [CCS]. We need to make sure our laws and regulations accelerate, not hinder, our environmental goals.¹³⁶

Thirty-two states, pursuing a wide range of energy and environmental policies, have created a regulatory environment conducive to CCS deployment. Not only is CCS adequately demonstrated, it is actively encouraged by a majority of states in anticipation of federal requirements that reasonably require its use, such as the Current Standard.

¹³⁰ N.M. Stat. Ann. § 7-9G-2.

¹³¹ N.M. Stat. Ann. § 62-6-28.

¹³² Wash. Rev. Code Ann. § 80.80.040. As of March 2018, Washington fossil-fueled plants of 25-350 MW capacity must meet an even *lower* emissions limit, 970 lb CO₂/MWh. Wash. Admin. Code § 173-407-130.

¹³³ N.D. Cent. Code § 57-60-02.1; Mont. Code Ann. § 69-8-421; Tex. Tax Code Ann. § 171.602; Mich. Comp. L. Ann. § 460.1047; Kan. Stat. Ann. § 79-233; Minn. Stat. Ann. § 216H.03. Montana's law outright bans new coal-fired plants, unless the plant uses CCS to capture at least 50 percent of CO₂ emissions. In Minnesota, plants using 100-percent CCS do not fall under the State's coal-fired plant ban and offset exemption process.

¹³⁴ See, e.g., IPCC 2018 Summary at 17.

¹³⁵ CCS Sen. Hrg. at 2, opening stmt. of Sen. Barrasso (R-Wyo.).

¹³⁶ *Id.*

D. The history of the Clean Air Act and court precedent allow for a power plant emission standard that may be more expensive to meet in some locations than others.

EPA's new, *de facto* understanding that Clean Air Act section 111(b) mandates that any performance standard provide all potential sources in each category an equal economic opportunity everywhere in the country is incorrect. EPA now rejects partial CCS technology in large part on its unsupported claim that "it could be prohibitively expensive for developers to secure sufficient quantities of water in arid regions of the country." Proposed Rule at 65,443/3. But section 111(b) was not intended to equalize compliance costs nationwide so as to ensure that new sources could be built and operated in every conceivable location in the country for the same price. Instead, Congress designed section 111(b) so as to prevent states with cleaner air from using that to gain an advantage over other states and thereby allowing their own air quality to deteriorate. *ASARCO Inc. v. EPA*, 578 F.2d 319, 328 n.25 (D.C. Cir. 1978) (explaining that Congress sought to dis-incentivize "states with presently low levels of pollution [from] adopting lenient State Implementation Plans to attract industry until pollution reached the national limits" and to prevent industry from "forum shopping" on that basis). That is, Congress knew that section 111(b) standards would influence geographical patterns of industrial development.

As the record EPA assembled during the 2015 rulemaking shows, in the event that an electricity supplier chooses to build a new coal-fired plant, the captured CO₂ can be sent out of state for storage; alternatively, economically reasonable compliance options besides CCS are available, such as co-firing with gas or employing integrated gasification. 2015 Preamble at 64,545. Under the Current Standard, a future developer of new generation in an area lacking known CO₂ storage capacity has several options and would naturally evaluate whether it was more economical to first ship coal into the state for burning and then ship CO₂ back out for storage, or to co-fire the coal plant with gas to meet the standard, or to build a plant that is not powered by coal. These choices are similar to location-specific considerations power plant developers always face.

From its inception, section 111(b) has allowed EPA to set emission standards that affect the relative cost of operating a new power plant in different areas of the country. *See Sierra Club*, 657 F.2d at 339 (discussing changes in economic incentives in different regions of the country due to evolution of section 111(b) controls on new coal plants); *Alliance for Clean Coal v. Miller*, 44 F.3d 591, 593 (7th Cir. 1995) (same). Congress has been fully aware that section 111(b) performance standards set by EPA affect economic incentives for where plants are built and what fuel they burn. As Congress directed, in 2015 EPA took costs into consideration in setting the Current Standards. *See* 42 U.S.C. § 7411(a)(1). EPA performed this analysis and determined that the costs of meeting the Current Standards would be reasonable and that they would not cause adverse economic impacts. 2015 Preamble at 64,558-73, 64,592-94. As explained below, the Proposed Rule fails to provide sufficient information to show that the ability to comply with the Current Standard is so geographically constrained that its cost should now be deemed unreasonable. *Fox*, 556 U.S. at 515-16.

E. EPA lacks a reasoned basis for reversing its determination that geographic availability of CCS is sufficient for CCS to be considered BSER.

In the 2015 rulemaking EPA examined the volume and suitability of CO₂ geologic storage (GS) capacity in each state as well as nationwide, and presented its calculations in a detailed Geographic Availability Technical Support Document.¹³⁷ Based on Department of Energy data, EPA found that “areas of the United States with appropriate geology have a sequestration potential of at least 2,035 billion metric tons of CO₂ in deep saline formations.” 2015 Preamble at 64,578/3-79/1. These saline formations thus have the potential to store as much CO₂ as all existing coal-fired plants in the country would emit if they operated for another 1,000 years.¹³⁸ EPA explained that it relied on “a conservative outlook of potential areas available for the development of CO₂ storage in that we include only areas that have been assessed to date.” *Id.* at 64,583. Based on this state-by-state analysis, EPA also determined that “[s]ubsurface formations suitable for GS of CO₂ captured from affected EGUs are geographically widespread throughout most parts of the United States.” *Id.* at 64,575/3.

Even in most of those areas where there was no already-identified CO₂ storage capacity, EPA found that a coal-fired plant could locate there and transport captured CO₂ via pipeline a reasonable distance to a geological storage area. 2015 Preamble at 64,583/1 (“[T]he vast majority of the country has existing or planned CO₂ pipeline, active CO₂-EOR operations, the necessary geology for CO₂ storage, or is within 100 kilometers of areas with geologic sequestration. A review of Figure 1 indicates limited areas that do not fall into these categories.”). Moreover, EPA found that, due to the interconnected nature of the electric grid, a new coal-fired plant could be built closer to an area with geological storage capacity and supply electricity to areas that do not have that capacity. *Id.* at 64,541/1 (explaining that “geologic sequestration sites are widely available, and a steam-generating plant with partial CCS that is sited near an area that is suitable for geologic sequestration can serve demand in a large area that may not have sequestration sites available”).

Given the widespread availability of and access to geological storage capacity, as well as alternative compliance options other than partial CCS, EPA concluded that partial CCS was adequately demonstrated for the purposes of section 111(a). 2015 Preamble at 64,597/1. Indeed, EPA concluded that considering all available options, a new coal-fired plant could theoretically be built anywhere in the country.¹³⁹

EPA now proposes to reverse all of these conclusions for two reasons: First, by referring to studies it already had during the 2015 rulemaking, it now thinks a specific geological

¹³⁷ See U.S. EPA, Technical Support Document: Geographic Availability, 6-7 (July 31, 2015), Docket ID EPA-HQ-OAR-2013-0495-11772 (tabulating state-by-state CO₂ storage resources).

¹³⁸ See 2015 Preamble at 64,523 tbl.4.

¹³⁹ See, e.g., 2015 RTC, Response 6.3-88, at 6-55 (“[T]he EPA believes that a new steam generating affected source could meet the promulgated standard and be located anywhere in the country. There is available sequestration capacity in most areas of the country, and there are alternative ways a new EGU could meet the standard, not involving sequestration, should a new source decide to locate in an area where these sequestration opportunities are unavailable.”).

formation—unmineable coal seams—that it did *not* rely on in 2015 should not be relied on. Second, because it rains less in some parts of the United States than it does in others, “many sequestration sites might not have sufficient water resources to operate CO₂ capture equipment.” *See* Proposed Rule at 65,444/1 (stating that the “combination” of these two factors leads EPA now to reject its 2015 finding that the geographical availability of CCS was adequate). Neither of these factors is sufficient to support EPA reversing its well-considered determination in 2015 that partial CCS was sufficiently geographically available that it could serve as the BSER. *See Fox*, 556 U.S. at 515-16.

1. EPA fails to justify reversing its finding that CO₂ storage capacity is adequate.

EPA bases its reversal of its determination that CO₂ storage capacity is adequate on its decision to exclude unmineable coal seams as possible areas for geological sequestration, which it says reduces the acreage of the United States that possesses access to known CO₂ storage capacity by 4 percent. But EPA was clear in 2015 that it never based the Current Standard on the availability of CO₂ storage in unmineable coal seams anyway. EPA cannot reverse its finding on the geographical availability of CCS by rejecting a fact it never even relied on to make its earlier determination. Further, EPA has no new basis for rejecting unmineable coal seams, and even if it did, national CO₂ storage capacity is more than adequate and is available to the vast majority of the country. EPA’s justifications fail.

a. EPA lacks a reasonable basis for reversing its position that unmineable coal seams can be used for geologic storage.

EPA says in the Proposed Rule that it no longer believes unmineable coal seams have the potential to store CO₂, and “EPA has excluded this type of formation from potential GS areas,” in part because there have been no large-scale demonstrations of CO₂ storage in those formations. Proposed Rule at 65,442/1-2. “The elimination of unmineable coal seams reduces the geographic availability of sequestration areas by approximately 4 percent. [¶] For these reasons, GS may not be as widely geographically available as assumed in the 2015 analysis.” *Id.* at 65,442/3.

Excluding storage in unmineable coal seams cannot support EPA changing its position that partial CCS is adequately demonstrated because EPA never based its 2015 BSER determination on the use of unmineable coal seams anyway. Instead, in the 2015 rulemaking EPA explicitly grounded its analysis only on the availability of CO₂ storage in deep saline formations. EPA explained this in 2015 in response to a criticism that there was little experience injecting CO₂ into coal seams for permanent storage because of various setbacks: “The BSER analysis and RIA rely on GS in deep saline formations. Current estimates of storage capacity indicate that coal seams provide only a small percentage of total US storage capacity.” 2015 RTC, Response 6.3-96, at 6-62; *see also* 2015 Preamble at 64,588/2 (“The BSER determination and regulatory impact analysis for this rule relies on GS in deep saline formations.”); *id.* at 64,579/2 (“[T]he determination that the BSER is adequately demonstrated and the regulatory impact analysis for this rule relies on GS in deep saline formations.”); *id.* at 64,590/3 (“[T]he BSER determination and regulatory impact analysis for this rule relies on GS in deep saline formations, not on EOR.”).

In addition, the studies EPA says now, “upon further review,” make it doubt the viability of storage in unmineable coal seams were already in its possession during the 2015 rulemaking. *See* Proposed Rule at 65,442 nn.79-82 (citing to studies from 2013 and 2014). While EPA now says that the possibility of “coal swelling” mentioned in these pre-2105 reports “raises doubts regarding the feasibility of larger-scale GS in unmineable coal seams at this time,” *id.* at 65,442/2, one report EPA cites in this same discussion states that although “[c]oal swelling . . . is often cited as the major technical concern relative to CO₂ storage in coal seams . . . this concern is based on very limited and often conflicting laboratory and field data.”¹⁴⁰

EPA unacceptably fails to explain why it interprets preexisting data from 2014 and earlier differently than it did before. *See Pub. Citizen v. Steed*, 733 F.2d 93, 101 (D.C. Cir. 1984) (“In any event, NHTSA has not shown that these flaws were different in kind or quantity from those that have been pressed on the agency for the past ten years. They were old and known problems that had been found insufficient to preclude use of the procedures in the past, and the evidence in the record does not warrant NHTSA’s dramatic change of position.”).

b. Even under EPA’s new measurement of 4 percent less acreage with access to storage, national and regional capacity is adequate.

EPA now claims that a 4-percent reduction in the acreage of the country convenient to geological sequestration (due to the elimination of unmineable coal seams) means that geological storage “may not be” as widely available as it believed in 2015. As explained above, this cannot logically support EPA changing its position that partial CCS is BSER. Moreover, it does not support a finding that geological storage is inadequate, as the evidence shows storage capacity is even more available than EPA assumed in 2015.

As EPA itself points out in the Proposed Rule, its “updated” analysis of geographic availability shows that estimates of storage capacity in deep saline formations—the formations EPA relied on in 2015 to find that partial CCS is BSER—actually *increased* since the 2015 rulemaking. Proposed Rule at 65,441 n.77 (“For deep saline formations, the low-end estimate of storage resource increased from 2,100 billion metric tons to 2,379 billion metric tons, and the high-end estimate increased from 20,014 billion metric tons to 21,633 billion metric tons.”). EPA does not disagree with its 2015 determination that CO₂ storage in deep saline formations should serve as the basis of its BSER analysis.¹⁴¹ Thus, the capacity to store CO₂ in the type of formation EPA says is relevant is even greater now than it was in 2015.

¹⁴⁰ J. Litynski et al., Using CO₂ for enhanced coalbed methane recovery and storage, CBM Review, 2, June 2014, Docket ID EPA-HQ-OAR-2013-0495-11941, Attachment 2, *cited in* Proposed Rule at 65,442 n.81.

¹⁴¹ Some language in the Proposed Rule could be read to suggest that EPA is reversing its position and contradicting NETL’s conclusion that saline formations are suitable for CO₂ storage. *See* Proposed Rule at 65,442/1 (observing that saline storage has not been demonstrated “at all locations”); *but see id.* at 65,442,3 (explaining that updated information on saline formations and EOR “do not significantly change the EPA’s understanding of which areas are amendable to GS”). EPA explicitly says, however, that its new determination that the geographical availability of CCS is too limited to be BSER is based *only* on two factors: the

This increase in storage capacity cannot support EPA changing its mind on the availability of storage capacity, one of the two factors that underlie its proposed finding that CCS is not geographically available.¹⁴² See *Kansas City v. Dep't of Housing & Urban Dev.*, 923 F.2d at 194 (agency decision “cannot survive review” when based on a factual premise contradicted by the record).

c. Any reduction in access to storage is insufficient to justify EPA's change of position because many areas EPA says have limited storage access are unlikely to be chosen by developers for new coal-fired plants.

EPA also fails to refute its 2015 conclusion that a developer of new coal-fired energy would be unlikely to locate in certain areas of the country, which renders the small alleged reduction in acres of the country with known storage capacity of uncertain relevance to an analysis of geographical availability. EPA observed in the 2015 rulemaking that “[s]ome states have emission standards that effectively prohibit new uncontrolled coal-burning electricity generating units from locating within their borders, so the issue of geographic availability is moot as to such states.” 2015 RTC, Response 2.1-29, at 2-12 to 2-13; see also 2015 Preamble at 64,576/3 (“[A] few states do not have geologic conditions suitable for GS, or may not be located in proximity to these areas. However, in some cases, demand in those states can be served by coal-fired power plants located in areas suitable for GS, and in other cases, coal-fired power

reduction in estimated storage areas by 4 percent (due to elimination of unmineable coal seams) and the lack of rainfall in some areas. *Id.* at 65,444/1 (reversing its former position due to the “combination” of these two factors). To the extent that EPA is basing its proposed determination that CCS is not adequately available on some new interpretation of the suitability of saline formations for storing CO₂, it improperly fails to provide notice of this rationale to the public, as it never states on what ground it would be reversing its previous findings on saline storage. See *United Food v. NLRB*, 880 F.2d at 1436 (agencies “must accept responsibility for clarifying and identifying the standards that are guiding its decisions”). Moreover, that saline storage may not be available “at all locations” or may be easier to use in some areas compared to others does not mean that EPA cannot consider it in its BSER analysis, as described in section III.D, above.

¹⁴² EPA also completely ignores the fact that the Department of Energy has determined that the total potential CO₂ sequestration capacity across all formations is actually at least 9 percent greater than EPA assumed at the time the Current Standard was finalized in 2015. The 2015 rulemaking relied on the Fourth Edition of the *Carbon Storage Atlas* (2012) (Docket ID EPA-HQ-OAR-2013-0495-11410). See 2015 Preamble at 64,578 n.379. As the Proposed Rule acknowledges, after the 2015 rulemaking NETL published an updated Fifth Edition (2015) (Docket ID EPA-HQ-OAR-2013-0495-11941 [attachment]). See Proposed Rule at 65,441/2. The 2012 Fourth Edition of the *Atlas* reports a “low” estimate of total storage capacity as approximately 2,380 billion metric tons (at page 125), whereas the updated 2015 Fifth Edition has a “low” total estimate of 2,618 billion metric tons (at page 111). See also Press Release, U.S. Department of Energy, NETL’s 2015 Carbon Storage Atlas Shows Increase in U.S. CO₂ Storage Potential (Sep. 28, 2015), <https://www.energy.gov/fe/articles/netl-s-2015-carbon-storage-atlas-shows-increase-us-co2-storage-potential>.

plants are unlikely to be built in those areas for other reasons, such as the lack of available coal or state law prohibitions and restrictions against coal-fired power plants.”).

EPA’s 2018 economic analysis agrees, noting that various states have created disincentives for new coal-fired construction through state initiatives or actual limits on power plant emissions. *See* 2018 Economic Impact Analysis, at 3-17 to 3-18. Yet EPA’s revised analysis of geological storage availability does nothing to correlate the 4 percent of acres it now says have no access to known storage capacity with areas in which a new coal-fired plant is likely to be built. This failure to determine whether the alleged 4-percent reduction in acreage actually changes ability of developers to find a suitable site for a new coal-fired plant makes EPA’s new conclusion that geological storage “may not be” as widely available arbitrary and capricious.

d. EPA improperly ignores its previous determination that the interconnected nature of the electricity grid means that developers of new coal-fired power continue to have the option to build a plant anywhere in the country.

EPA has recognized that a system of emission reduction can be BSER even though it might not be economical to implement that system on every acre of the country. In the proposal underlying the Current Standard, EPA stated that a technology can be the basis of a section 111 emission standard even if it is not practical in every location: “if the EPA promulgates section 111 emission limits based on a particular type of technology, and for economic or technical reasons, sources are able to utilize that technology in only certain parts of the country and not other parts, that result should not be viewed as inconsistent with congressional intent for CAA section 111.” 79 Fed. Reg. at 1,467. EPA reaffirmed that position in the final rule in 2015. 2015 Preamble at 64,540/3-41/1. This is especially true in the electric power sector, where demand can be served by suppliers hundreds of miles away. EPA explained that:

[E]lectricity demand in states that may not have geologic sequestration sites may be served by coal-fired electricity generation built in nearby areas with geologic sequestration, and this electricity can be delivered through transmission lines. This method, known as ‘coal-by-wire,’ has long been used in the electricity sector because siting a coal-fired power plant near the coal mine and transmitting the generation long distances to the load area is generally less expensive than siting the plant near the load area and shipping the coal long distances.

2015 Preamble at 64,582/3-82/1.

EPA fails to clarify in the Proposed Rule whether it is (a) reversing its position on that issue, or (b) adopting a rule that the technology has to be economically implementable in a certain percentage of the acres of the country, and that the alleged 4-percent reduction in areas with storage capacity pushes the percentage below that new, unspecified threshold. This is indicative of arbitrary and capricious rulemaking.

First, EPA ignores and does not dispute the region-by-region analysis in its 2015 Geographic Availability Technical Support Document, which found that the current rule “does not negatively impact the ability of these regions to access new coal generation to the extent that coal is needed to supply demand and/or those regions want to include new coal-fired generation

in their resource mix.” 2015 Preamble at 64,582/3-83/2. *See Fox*, 556 U.S. at 516 (“a reasoned explanation is needed for disregarding facts and circumstances that underlay or were engendered by the prior policy”).

Second, if EPA is changing its position that a system of emission reduction need not be available everywhere in the country, it displays no awareness of that fact. *Id.* at 515 (“[T]he requirement that an agency provide reasoned explanation for its action would ordinarily demand that it display awareness that it is changing position.”). If, instead, EPA still believes that a system of emission reduction can form the basis of BSER even if it is not economically achievable on every acre of the country, but is now for the first-time adopting a “percentage of the acres in the country” standard, it must explain what the standard is and why the Current Standard does not meet it. *See, e.g., United Food v. NLRB*, 880 F.2d at 1435-36 (“As it is now, we are at a loss to know what kind of standard it is applying or how it is applying that standard to this record . . . the Board must accept responsibility for clarifying and identifying the standards that are guiding its decisions.”).

2. EPA fails to justify its new position that partial CCS cannot be BSER because it requires water.

The second pillar¹⁴³ of EPA’s new opinion that partial CCS is not available in enough areas of the country to be BSER is based solely on its observations that a plant employing CCS uses more water than one that does not and that some areas of the country do not receive as much rainfall as others. Even accepting both of these things as true, both apply to many pollution control technologies mandated by federal law—they require water, and rainfall is not uniform throughout the United States. EPA’s rationale in the Proposed Rule amounts to a new legal interpretation of section 111(a): because some parts of the country have less rainfall than others, no system of emission of emission reduction can be BSER if it increases the amount of water a source would use. That position finds no support in the Clean Air Act or court precedent. Moreover, EPA was well aware that CCS required water and that some areas of the country have less water resources available than others, but it nevertheless concluded that partial CCS was reasonably available throughout the United States and was BSER. EPA proposes to reverse its position without any new facts and without justifying its change on any factor it is required to consider under section 111(a) in determining BSER.

a. EPA does not explain why it alters its calculation of water increase due to CCS or why its new calculation renders its previous findings invalid.

In finalizing the Current Standard, EPA analyzed the increase in water usage for various levels of CCS. 2015 Preamble at 64,592-93. EPA recognized that “[s]imilar to other air pollution controls—such as a wet flue gas desulfurization scrubber—utilization of post-combustion amine-based capture systems results in increased consumption of water.” *Id.* at 64,593/1. EPA analyzed NETL studies and calculated that a new coal-fired plant implementing partial CCS to meet the Current Standard “would see an increase in water consumption (the difference between the

¹⁴³ The other prong of EPA’s attack on its own 2015 geographical availability findings is based on eliminating unmineable coal seams as a CO₂ storage option. *See* section III.D.1, above.

predicted water withdraw and discharge) of about 6.4 percent¹⁴⁴ “compared to the same plant without CCS. *Id.* at 64,592. Although it well understood that partial CCS would increase water usage somewhat, EPA determined that the increase was reasonable. 2015 RTC, Response 6.3-12, at 6-11 (“The EPA is aware that the use of CCS can increase water usage/consumption at a new facility. The EPA has carefully evaluated this issue in preamble section V.O.2 [pages 64,592-93] and finds the water use impacts of the final standard of performance to be reasonable.”).

The Proposed Rule does not contain any analysis that undermines EPA’s 2015 conclusion that water availability did not preclude a finding that partial CCS is BSER. At most, EPA now says that the relevant type of plant for water availability analysis should be changed to one that operates with less water and emits a higher amount of CO₂, so that when a greater level of CCS is applied, the percentage increase in water use is greater (28-percent increase compared to 7.7-percent increase). Specifically, EPA explains that while the water usage analysis it used in 2015 was based on NETL studies of a “bituminous-fired EGU with a wet scrubber and a cooling tower,” a “more appropriate percentage increase comparison for arid western markets and other locations in water-scarce environments is a subbituminous-fired PC unit with spray drying or a fluidized bed unit and a cooling tower.” Proposed Rule at 65,443/1-2. That is, EPA now says that to determine what percent increase in water use partial CCS requires, it should make the comparison using a plant that uses less water without CCS (dry scrubbing instead of wet scrubbing) but will require more water to implement a higher level of CCS (23 percent for subbituminous-fired instead of 16 percent for bituminous-fired). EPA thereby inflates the numerator and deflates the denominator in order to make the percentage increase in water use seem greater.

EPA provides no justification for changing the way it calculates water usage. It does not explain why a bituminous-fired unit with wet scrubbing is no longer relevant to the analysis, even though it acknowledges that is “one common configuration for an EGU and associated air pollution control device,” Proposed Rule at 65,443/2, and it in fact bases its 2018 LCOE and capital cost analysis on that type of plant, *id.* at 65,438/1. EPA does not explain why the only point of comparison should be a plant that consumes less water without CCS and would have to consume even more water with it. EPA does not explain why the only relevant point of comparison is a plant built in “arid western markets” and “water scarce environments.”

Even if EPA could demonstrate that that type of plant is a more relevant comparison point, EPA never explains why a 7.7-percent increase in water usage is reasonable but a 28-percent increase is unreasonable. If EPA is applying some new particular test of water-consumption-percentage-increase reasonableness, it does not reveal that to the public.

Further, EPA never analyzes the cost increase this additional water consumption would cause. Whether that additional cost is minor, reasonable, or exorbitant remains a mystery. Its failure to perform any financial calculations whatsoever related to water did not stop EPA from concluding, however, that “this increase in water requirements is so great that it could be *prohibitively expensive* for developers to secure sufficient quantities of water in arid regions of the country.” Proposed Rule at 65,443/1 (emphasis added). Or, in the absence of any evidence, it also could not be too expensive at all. EPA’s opaque reasoning and unsupported conclusions

¹⁴⁴ As EPA points out in the Proposed Rule, the 6.4 percent figure is a mathematical error found in the 2015 Preamble. The correct figure is 7.7 percent. *See* Proposed Rule at 65,443 n.87.

demonstrate that its reversal of position on the reasonableness of CCS water usage is arbitrary and capricious.

b. The previously known fact that the western U.S. receives less rainfall than the eastern U.S. does not justify EPA rejecting its determination that partial CCS is BSER.

Even in the context of the cursory analyses underlying EPA's Proposed Rule, its Water Review Memorandum stands apart.¹⁴⁵ EPA's Water Review Memorandum contains approximately two pages of new text, much of it irrelevant, and two maps showing the locations of coal- and gas-fired plants, superimposed over a map of annual rainfall. Boiled down to its essence, the Memorandum amounts to a non sequitur: it rains less in the western United States than it does in the East, and a coal-fired plant using partial CCS requires more water than one that does not use partial CCS, therefore it is too hard to use partial CCS where it does not rain as much.

EPA says that the only thing it did to support its water availability analysis was to "review[] annual average rainfall totals as an estimation of water availability." Water Review Memorandum, 4. "This approach indicates that the Western U.S. (i.e., areas west of a line running from central Texas to North Dakota), excluding the Pacific Northwest, has lower amounts of water available for EGUs." *Id.* This observation, to say the least, is not a new revelation.

More importantly, it does not support EPA's reversal of position. First, EPA does not explain why annual rainfall totals are a good proxy for the ability of an industry to access water in general or the ability of a coal-fired plant to operate in a region in particular. There is good reason to think rainfall is not determinative, however. The map EPA provides in Figure 1 of the Memorandum in fact shows many existing, water-consuming coal-fired plants located in areas EPA considers too arid. Figure 1 also shows that plants tend to be located on river systems, where a plant can utilize water other than the amount of water that happens to fall on the plant as rain. EPA has presented no facts showing that lower rainfall totals on a regional basis prevent construction of power plants near surface or groundwater sources.

Second, EPA's observation that the western half of the country "has lower amounts of water available for EGUs" is meaningless in a BSER analysis. By EPA's reasoning, the western half of the country has less water available for *everything*; and yet tens of millions of people live there, engaging in productive water-using industry and agriculture. If EPA is correct that CCS cannot be BSER because there is less rainfall in one half of the country than in the other, then no pollution control technology that requires any amount of water could ever be BSER, as there will always be regional variation in rainfall. EPA's sole reliance on simply dividing the country into a dry half and a wet half is insufficient to overcome its previous finding that water availability does not prevent a finding that partial CCS is BSER.

EPA next concludes that "many sequestration sites might not have sufficient water resources to operate CO₂ capture equipment" because "a comparison of areas of the country with

¹⁴⁵ U.S. EPA, Review of the Water Consumption and Availability Impacts on the Viability of Carbon Capture and Storage Projects (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11942 (Water Review Memorandum).

lower rainfall amounts shows considerable overlap with areas the county with sequestration sites.” Water Review Memorandum, at 4. EPA never explains what this “comparison” consists of, so the public has no way to evaluate its methodology. A simple visual comparison, however, of the rainfall map in Figure 1 of the Water Availability Memorandum to Figure 1 of EPA’s contemporaneous Geographic Availability of Geologic Sequestration Memorandum¹⁴⁶ shows that potential sequestration sites exist throughout the country, in both those areas with more rain and those with less. EPA’s unexplained conclusion is wrong.

EPA also speculates about the motivations of future power plant developers, without any evidence to back up its assertions. For instance, in the Water Review Memorandum EPA concludes that, in addition to arid regions, “water use concerns are likely applicable to areas with larger amounts of rainfall as well.” Water Review Memorandum, at 5. EPA’s sole data point for this conclusion is that one coal-fired power plant with dry cooling exists in Virginia. EPA does not analyze what could be the myriad other reasons this one plant in Virginia employs dry cooling, does not support its conclusion with any evidence, and does not reconcile its conclusion with the fact that the other three coal-fired plants using dry cooling are located in what EPA considers an arid region. Furthermore, despite lower rainfall amounts, almost all coal-fired plants in the West use wet cooling, not dry cooling, as shown in Figure 1 of the Memorandum.

Similarly, EPA determined that a developer of a new coal-fired plant would likely want to use dry cooling because 15 percent of gas-fired plants use dry cooling, and they are “located throughout the U.S., further indicating that water use concerns are more widespread than just arid locations with limited rainfall.” *Id.* EPA does not explain why the data supports that inference more than a more obvious alternative, such as the fact that 85 percent of gas-fired plants use wet cooling (*see* Water Review Memorandum, Fig. 2)—even the vast majority of those plants in the “arid” West—shows that water concerns do not prevent power plant development in areas with less rainfall.

EPA’s revised conclusions about water availability fail basic tenets of rational decision-making. EPA utterly failed “examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made,” *State Farm*, 463 U.S. at 43, and failed to provide “a reasoned explanation . . . for disregarding facts and circumstances that underlay or were engendered by the prior policy,” *Fox*, 556 U.S. at 515-16.

3. EPA misinterprets the Clean Air Act as preventing EPA from determining that BSER can be a technology that is more expensive to use in some areas of the country than others.

EPA previously concluded that, although CCS was not available in a few areas, it is available in vast areas of the country and therefore any geographic limitations were not enough to prevent CCS from being considered to be adequately demonstrated. *See* 2015 RTC, Response 3.3-39, at 3-106 (“The EPA recognizes that the cost of CCS may vary depending upon the proposed location of the EGU based on geographic and other factors including locations of

¹⁴⁶ U.S. EPA, Geographic Availability of Geologic Sequestration, 5 (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11941.

potential sequestration sites; however the EPA carefully reviewed the assumptions on which the transport and storage cost estimates are based and continues to find them reasonable.”).

EPA’s new interpretation that CCS is not adequately demonstrated because there are a few areas of the country in which it may cost more to employ CCS (due to water availability or CO₂ transmission costs) is in effect the adoption of a new legal position: a system of emission reduction can only be adequately demonstrated if it can be profitably employed on all types of sources in all areas of the country. This is not a requirement of the Clean Air Act, and EPA has not attempted to justify its change of position. *See Pub. Citizen v. Steed*, 733 F.2d 93, 101 (D.C. Cir. 1984) (finding agency reversal of regulation arbitrary and capricious where alleged problems with test procedure were not “different in kind or quantity from those that have been pressed on the agency for the past ten years. They were old and known problems that had been found insufficient to preclude use of the procedures in the past, and the evidence in the record does not warrant [agency’s] dramatic change of position.”).

F. EPA cannot issue a lowest-common-denominator standard like this when it has the option to subcategorize based on geographic factors. (C-15)

EPA developed the new BSER in the Proposed Rule by looking at the emissions from existing coal-fired plants that are less efficient (using dry cooling), that burn dirtier coal (subbituminous), and that it expects will operate in areas of the country with the most limited water supplies (even though most plants in these areas use wet cooling). Then—to allow them to emit more CO₂ than necessary—EPA would apply the resulting less-stringent emission standard to even those new plants using more efficient technology, burning coal with less CO₂ output, in areas where water is abundant. Nothing in the Clean Air Act permits EPA to weaken a legally promulgated section 111(b) standard just so that it can be met by a higher-emitting type of source—which may or may not ever be built. *See Portland Cement Ass’n v. EPA*, 665 F.3d 177, 191 (D.C. Cir. 2011) (holding that EPA could adopt section 111 standards of performance based on the performance of a kiln type that kilns of older design would have great difficulty satisfying). Instead, if warranted after a thorough analysis of facts, EPA may subcategorize within the source category based on geographical location of the source where it is warranted. 42 U.S.C. § 7411(b)(2).

To the extent that in the future EPA may wish to present facts supporting different BSER for subcategories of coal-fired power plants based on geography (e.g., water availability, CO₂ storage capacity, or offsetting costs by enhanced oil recovery), it may propose a new rule at that time; but it may not now adopt such subcategorization in a final rule given the lack of notice and opportunity to comment on any such subcategorization. *See* 42 U.S.C. § 7607(d)(3) (requiring disclosure, at the time of proposal, a rule’s “major legal interpretations and policy considerations”).

IV. IT IS IRRATIONAL FOR EPA TO ESTABLISH A STANDARD FOR RECONSTRUCTED PLANTS THAT ALLOWS A PLANT TO RECONSTRUCT IN SUCH A WAY THAT IT EMITS MORE CO₂ THAN IT DID BEFORE. (C-19, C-20)

After reviewing the record of the actual performance of modern coal-fired plants, EPA determined in 2015 that “the BSER for reconstructed steam generating units should be based on the performance of a well operated and maintained EGU using the most efficient generation technology available.” 2015 Preamble at 64,600/3. EPA concluded that this technology was a supercritical pulverized coal or supercritical circulating fluidized bed boiler. It established the reconstructed plant standard at 1,800 lb CO₂/MWh-g after determining that this level of emission was “achievable by all the primary coal types.” *Id.*

In the Proposed Rule EPA rejects its previous determination that a *new* coal-fired plant could limit its emissions to 1,800 lb CO₂/MWh-g with modern upgrades, and instead says that a new a plant could at best achieve 1,900 lb CO₂/MWh-g. EPA changes its expected plant performance by including a wider variety of existing coal-fired plants in its consideration of BSER, including plants using dry cooling and burning subbituminous coal. (As described in section III.E.2.a, above, EPA fails to provide a rational explanation for that choice, since it does not expect that to be a likely configuration for new plants.) EPA describes the CO₂ emissions from these plants as exhibiting a “minimum level of control, since to date no operating coal-fired EGUs have had a federal regulatory driver to minimize the CO₂ emission rate.”¹⁴⁷ EPA then proceeds to make that unsupported, minimum level of control the emission standard for *reconstructed* plants as well.

EPA lacks a reasoned basis to replace the Current Standard with the proposed higher 1,900-lb-CO₂/MWh-g standard, based on the “minimum level of control” exhibited by plants employing technologies and burning coal types not likely to be used at a reconstructed plant. For example, EPA provides no evidence or reason to believe that a plant undergoing reconstruction would switch from wet cooling to less efficient dry cooling or would switch from burning bituminous coal to burning higher-emitting subbituminous coal. And yet, the new emission standard EPA proposes to apply to such plants, 1,900 lb CO₂/MWh-g, is based on these other technologies and fuel types. In any event, it is irrational for EPA to allow a plant to adopt technology producing greater CO₂ emissions when it undergoes reconstruction when EPA previously found that the 1,800-lb-CO₂/MWh-g was achievable for a range of coal types. EPA may not reverse its previous position when it fails to provide a reasonable explanation. *Fox*, 556 U.S. at 515.

¹⁴⁷ U.S. EPA, Memorandum, Best System of Emission Reduction (BSER) for Steam Generating Units and Integrated Gasification Combined Cycle (IGCC) Facilities, 9 (Dec. 2018), Docket ID EPA-HQ-OAR-2013-0495-11954.

V. IT IS ARBITRARY AND CAPRICIOUS FOR EPA TO WEAKEN THE EMISSION STANDARD TO ALLOW A PLANT TO MODIFY IN SUCH A WAY THAT IT EMITS MORE CO₂ THAN ITS OWN BEST HISTORICAL PERFORMANCE.

The Current Standard for modified plants is based on the individual plant's best historical annual CO₂ emission rate (not the partial CCS-based standard for new plants), with a floor on how low the plant's emissions must go after modification. EPA proposes to retain this individualized description of the BSER for a modified plant. Illogically, however, it proposes to raise the floor by 100 lb CO₂/MWh-g so that the same modified plant undergoing the same modification would be allowed to emit more CO₂, even if its operating history shows that it is capable of meeting the Current Standard. EPA has identified no reason this change is rational or in accord with the Clean Air Act.

To the extent EPA bases the new modified plant emission limit on its analysis of what a new plant could achieve, taking into consideration the same higher-emitting technologies and fuels, its decision is also arbitrary and capricious for the reasons described above regarding reconstructed plants. *See* section IV, above. Specifically, it is irrational for EPA to set the CO₂ emission limit of a plant burning bituminous coal and using wet cooling on the emissions achieved by a different kind of plant burning subbituminous coal and using dry cooling and emitting more CO₂. EPA provides no evidence that a plant undergoing a modification should be allowed to switch to a higher-emitting fuel source or technology. If a plant's operating history shows that it can achieve the Current Standard, there is no reason EPA should enable it to emit more CO₂ after it undergoes a modification.

To the extent that EPA is changing the maximally allowable emission rate of modified units simply to create numerical equivalence between its proposed new and modified standards, its proposal is invalid under the Clean Air Act. Congress told EPA to consider various things in setting a "standard of performance" under section 111(a)(1), but numerical equivalence with some other standard is not one of them. *State Farm*, 463 U.S. at 43 ("Normally, an agency rule would be arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider . . .").

VI. EPA HAD RATIONAL BASES AND LEGAL AUTHORITY TO ISSUE THE CURRENT STANDARDS, AND EPA CANNOT REVERSE THOSE POSITIONS DUE TO COMMENTS IT IS SOLICITING FOR THE FIRST TIME IN FOOTNOTE 25. (C-3, C-28)

EPA correctly determined in the 2015 rulemaking that it had legal authority to regulate CO₂ from power plants under section 111(b)(1)(B). 2015 Preamble at 64,530/2 ("In this rulemaking, the EPA has a rational basis for concluding that emissions of CO₂ from fossil fuel-fired power plants, which are the major U.S. source of GHG air pollution, merit regulation under CAA section 111."). The record contains overwhelming evidence showing that EPA had a rational basis to regulate this pollutant from these sources; indeed, any other finding would be irrational. EPA summarized that record in the 2015 Preamble:

The EPA's rational basis for regulating CO₂ under CAA section 111 is based primarily on the analysis and conclusions in the EPA's 2009 Endangerment Finding and 2010 denial of petitions to reconsider that Finding, coupled with the

subsequent assessments from the IPCC and NRC that describe scientific developments since those EPA actions. In addition, we have reviewed comments presenting other scientific information to determine whether that information has any meaningful impact on our analysis and conclusions.

Id. at 64,530/3-31/1. “The facts, unfortunately, have only grown stronger and the potential adverse consequences to public health and the environment more dire in the interim.” *Id.* at 64,531/1; *cf. Coalition for Responsible Regulation, Inc. v. EPA*, 684 F.3d 102, 120 (D.C. Cir. 2012) (“The body of scientific evidence marshaled by EPA in support of the [2009] Endangerment Finding is substantial.”).

EPA also determined that, in addition to supporting that rational basis, the facts in the record for the Current Standard would also be sufficient to support section 111(b)(1)(A) endangerment and cause-and-contribute findings, if they were required. 2015 Preamble at 64,530 (justifying the Current Standard as based on “analysis and conclusions in the EPA’s 2009 Endangerment Finding” coupled with subsequent scientific assessments); *id.* at 64,531/2 (finding that cited facts, including that fossil fuel-fired power plants “are responsible for almost three times as much [greenhouse gas pollution] as the emissions from the next ten stationary source categories combined,” support “a cause-or-contribute-significantly finding for CO₂” from these sources). The record before the agency provides ample support for its authority to regulate power plant CO₂ emissions under section 111(b), and there is no reason for EPA now to ignore that evidence and reach a different conclusion.

In footnote 25 of the Proposed Rule (page 65,432), however, EPA oddly requests comments on legal interpretations it is explicitly rejecting and not proposing. After summarizing the legal justifications it relied on in the 2015 rulemaking to regulate CO₂ from these sources, EPA reaffirms that it “is proposing to retain the statutory interpretations and record determinations” supporting its authority to promulgate the Current Standard. Proposed Rule at 65,432/1 & n.25. Nevertheless, in footnote 25 EPA invites comment on whether, in fact, it lacks the authority to regulate CO₂ from coal-fired plants, the very thing it is proposing to continue doing in this rulemaking.

A. EPA cannot reverse its position merely by asking for comments on whether it should adopt a new position diametrically opposed to both current law and the position it maintains in the Proposed Rule.

Section 307(d)(3) of the Clean Air Act requires EPA to issue a specific “proposed rule” as a focal point for public comments. In the Proposed Rule, however, EPA takes the highly unusual step of asking for comment on legal positions it explicitly claims it is *not* proposing to adopt. Proposed Rule at 65,432 n.25. EPA’s use of footnote 25 to solicit comments supporting legal interpretations it says it is not proposing raises the suspicion that the agency is simply fishing for grounds on which it can reverse these legal positions in the final agency action, and thereafter claim that the public had sufficient notice of that outcome in this Proposed Rule. This would violate bedrock principles of administrative rulemaking and the Clean Air Act.

In *Environmental Integrity Project v. EPA*, 425 F.3d 992 (D.C. Cir. 2005), the D.C. Circuit Court rejected a similar attempt by EPA. There, EPA proposed to codify its interpretation of the rules through an amendment of regulatory text, but wound up adopting a conflicting interpretation in the final action. In finding that EPA violated the Administrative Procedure Act,

the court observed that “[w]hatever a ‘logical outgrowth’ of this proposal may include, it certainly does not include the Agency’s decision to repudiate its proposed interpretation and adopt its inverse.” *Id.* at 998. The court explained that mentioning in the proposal the converse of the Agency’s proposed position—as EPA does here in footnote 25—does not satisfy basic administrative rulemaking requirements:

EPA argues that it met its notice-and-comment obligations because its final interpretation was also mentioned (albeit negatively) in the Agency’s proposal. However, this argument proves too much. If the APA’s notice requirements mean anything, they require that a reasonable commenter must be able to trust an agency’s representations about *which particular* aspects of its proposal are open for consideration. A contrary rule would allow an agency to reject innumerable alternatives in its Notice of Proposed Rulemaking only to justify any final rule it might be able to devise by whimsically picking and choosing within the four corners of a lengthy “notice.” Such an exercise in “looking over a crowd and picking out your friends,” does not advise interested parties how to direct their comments and does not comprise adequate notice

Id. at 998 (citations omitted); *see also Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d at 549; *Shell Oil Co. v. EPA*, 950 F.2d at 760.

EPA must not attempt to revoke the legal justifications for its Proposed Rule and the Current Standard based on comments it receives in response to its proposal *not* to change those justifications, as doing so would serve as a boundless exception to Clean Air Act rulemaking requirements.

B. There is no reason EPA should reverse its interpretation of section 111, which is that an endangerment finding need only be made once for each source category at the time that EPA lists that source category.

EPA is correct that it need not make a new endangerment finding each time it regulates an additional pollutant by a source category that is already listed under section 111(b)(1)(A), and it should not reverse its position. *See, e.g.*, 2015 Preamble at 64,529/3 (“[B]ecause the EPA is not listing a new source category in this rule, the EPA is not required to make a new endangerment finding with regard to affected EGUs in order to establish standards of performance for the CO₂ emissions from those sources.”). Many years ago EPA found coal-fired power plants to be significant contributors to air pollution that endangers public health and welfare, and it listed them pursuant to section 111(b)(1)(A).¹⁴⁸ Based on the fact that these sources were already listed, EPA’s legal position has been that it may establish additional standards of performance for the source category—such as the CO₂ standards it issued in 2015—so long as it demonstrates

¹⁴⁸ EPA listed coal-fired power plants as a source category for regulation under section 111 in 1971, finding that the category “causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare.” List of Categories of Stationary Sources, 36 Fed. Reg. 5,931 (Mar. 31, 1971).

that it has acted reasonably (i.e., with a “rational basis”) in setting the additional standards of performance under section 111(b)(1)(B).¹⁴⁹

In addition, there are no differences between greenhouse gases (such as CO₂) and other pollutants that would support EPA creating an exception to its current position that a separate endangerment finding is not required each time it regulates an additional pollutant by an already-listed source category. Such a change in position would be especially unwarranted where EPA already found the pollutant to endanger public health and welfare.¹⁵⁰ Furthermore, as EPA itself acknowledged in the 2015 rulemaking, the U.S. Supreme Court ruled in *Massachusetts v. EPA*, 549 U.S. 497, 520 (2007), that greenhouse gases meet the definition of “air pollutant” under the Clean Air Act and premised its decision in *AEP v. Connecticut*, 564 U.S. 410, 424 (2011), on its view that section 111 applies to greenhouse gas emissions. 2015 Preamble at 64,527/1.

C. EPA would not have a reasoned basis for reversing its current position that control of GHG emissions from new power plants is warranted under section 111(b).

1. The trend of lower CO₂ emissions from the power sector does not provide a rational basis for EPA to eliminate regulation of CO₂ emissions from these sources.

Although recent years have seen a welcome downward trend in CO₂ emissions from the power sector, this trend is not new since 2015, and nothing about it would support EPA reversing its position that it should impose CO₂ emission controls on new coal-fired plants. Congress created the Clean Air Act to protect the public health and welfare. EPA was correct to observe in the 2015 rulemaking that “a variety of factors may come into play in a decision to build new power generation, and we want to ensure that there are standards in place to make sure that whatever fuel is utilized is done so in a way that minimizes CO₂ emissions, as Congress intended with CAA section 111.” 2015 Preamble at 64,526/1. EPA may not assume that trends will continue nor ignore its statutory obligations in favor of letting trends in the marketplace provide the protections Congress directed EPA to provide the public.

The trend of decreasing CO₂ emissions from the power sector existed at the time EPA finalized the Current Standard, and thus it is not new evidence that could support EPA changing its rationale for regulating these emissions. EPA observed in 2015 that in recent years, “the nation has seen a sizeable increase in renewable generation such as wind and solar, as well as a shift from coal to natural gas. . . . From 2007 to 2014, use of lower- and zero-carbon energy sources has grown, while other major energy sources such as coal and oil have experienced declines.” 2015 Preamble at 64,524/1. EPA’s own data have reflected this trend for some time.¹⁵¹

¹⁴⁹ EPA’s legal interpretation is explained in Respondent EPA’s Brief (ECF #1659737), at 108-116, *North Dakota v. EPA*, No. 15-1381 (D.C. Cir. Feb. 6, 2017).

¹⁵⁰ See Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009).

¹⁵¹ U.S. EPA, “Carbon Dioxide Emissions, 1995-2018” (providing table of CO₂ emissions showing that downward trend existed in 2015), https://www.epa.gov/sites/production/files/2019-02/ec_co2_2018_1.png, link available at U.S.

EPA also reiterates that a shift from coal to natural gas has been taking place within the power sector for a decade. 2018 Economic Impact Analysis, at 3-16 to 3-17 & tbl.3-6 (explaining that “consistent with current trends, . . . natural gas-fired capacity has been the technology of choice for base load and intermediate load power generation. Table 3-6 illustrates this trend: from 2006 to 2016 net generation from coal decreased by 37.7%, while net generation from natural gas increased by 68.8%.”).¹⁵²

Furthermore, this source category, fossil fuel-fired power plants, and coal-fired plants in particular, continues to contribute a large amount of CO₂ to the atmosphere, in both absolute and relative terms. Given the harms produced by increasing atmospheric concentrations of CO₂,¹⁵³ it would be irrational for EPA to decide to remove existing emissions controls. In the 2015 rulemaking EPA presented data through 2013 showing that “fossil fuel combustion by the utility power sector—entities that burn fossil fuel and whose primary business is the generation of electricity—accounted for 38.3 percent of all energy-related CO₂ emissions,” and that “the utility power sector emits far greater CO₂ emissions than any other industrial sector,” specifically noting that “CO₂ emissions from fossil fuel-fired EGUs are nearly three times as large as the total reported GHG emissions from the next ten largest emitting industrial sectors in the GHGRP [Greenhouse Gas Reporting Program] database combined.” 2015 Preamble at 64,523. “Fossil fuel-fired EGUs are by far the largest emitters of GHGs among stationary sources in the U.S., primarily in the form of CO₂. Among fossil fuel-fired EGUs, coal-fired units are by far the largest emitters.” *Id.* at 64,522/3. And, in April 2018 EPA published its annual inventory of greenhouse gas sources in the U.S., which provided updated information about sources of CO₂ through 2016.¹⁵⁴ The updated emissions data confirm that CO₂ emissions from fossil fuel-fired power plants continue to dominate over all other industrial sectors and that coal-fired power plants in particular are by far the largest stationary source of greenhouse gases.¹⁵⁵

Regardless of whether CO₂ emissions from the power sector continue their slow decline or begin to increase, those emissions are too enormous to ignore. As EPA itself has observed, “the CO₂ emissions from even a single new coal-fired power plant may amount to millions of tons each year.” 2015 Preamble at 64,530/3. EPA had and still has a rational basis to control CO₂

EPA, Power Plant Emission Trends, <https://www.epa.gov/airmarkets/power-plant-emission-trends> (last visited Mar. 18, 2019).

¹⁵² Recent evidence shows that the trend of declining CO₂ emissions cannot be assumed to continue in perpetuity. Data EPA released on February 20, 2019, show that CO₂ emissions from power plants increased by 0.6 percent in 2018, the first such annual increase since 2013. https://www.epa.gov/sites/production/files/2019-02/view_2018_camd_emissions_data_1.xlsx. To the extent a downward trend in emissions could justify abstaining from regulation (which it cannot), that justification would of course be eliminated if the trend has stopped.

¹⁵³ See sections I.A. and I.B., above.

¹⁵⁴ U.S. EPA, U.S. Greenhouse Gas Emissions and Sinks: 1990–2016 (Apr. 2018), available at https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf.

¹⁵⁵ See *id.* at 1-16 tbl.1-4 (Key Categories for the United States (1990-2016)).

emissions from these sources. Moreover, it would have no rational basis to reverse its position and alter the regulatory status quo. *See Fox*, 556 U.S. at 515.

2. EPA could not lawfully eliminate emission standards for coal-fired plants on the basis of its projection that few or no new plants are likely to be built.

The fact that EPA estimates that “no more than a few new coal-fired EGUs can be expected to be built,” Proposed Rule at 65,432, does not provide EPA a rational basis for repealing its CO₂ emission standards for new coal-fired plants. The evidence continues to support EPA’s current position that regulation of new, modified, and reconstructed coal-fired plants is appropriate and, indeed, compelled by the Clean Air Act.

EPA’s expectations about the construction rate of new coal-fired plants are “[c]onsistent with the 2015 Rule” and therefore could not provide a rational basis for repeal. *Id.* at 65,436. As EPA recognizes in the Proposed Rule, it anticipated when it finalized the Current Standard that “few, if any, fossil-fuel-fired steam-generating EGUs will be built in the foreseeable future” due to the availability of cheaper generation options and other power-sector trends. *Id.* at 65,427 (citing 2015 Preamble at 64,515). The Proposed Rule confirms that those projections “remain generally correct.” *Id.*

Notwithstanding its assumptions about construction of new coal-fired plants, EPA’s decision to adopt the Current Standard was reasonable and consistent with the Clean Air Act. And there have been no relevant changes to EPA’s analyses or understanding since the 2015 rulemaking that would justify a change of course. EPA’s promulgation of the Current Standard correctly recognized that developers may prefer to invest in a new coal-fired plant despite the availability of cheaper generation options. “EPA has not received information since the 2015 Rule that would cause it to rule out that possibility.” Proposed Rule at 65,426. EPA’s regulation of new coal-fired plants also remains reasonable to manage plausible, even if unlikely, health and environmental risks.

a. EPA has already reasonably considered that industry may choose to invest in new coal-fired plants notwithstanding prevailing cost trends.

EPA explained in both the 2015 Preamble and Proposed Rule that a developer may prefer to build a new coal-fired plant even if cheaper generation options are available. *See* 2015 Preamble at 64,513; Proposed Rule at 65,436. That conclusion is consistent with how the industry operates in practice. Notably, developers are not all equally exposed to market pressures. A majority of the country’s coal-fired plants are publicly or cooperatively owned, or located in states where traditional cost-of-service regulation dominates.¹⁵⁶ Compared to

¹⁵⁶ Susan Tierney, Ph.D., Initial Evaluation: Operational and Investment Incentives of Different Owners of Coal-Fired Power Plants in Light of EPA’s Proposed Changes in the New Source Review Program, at 13 (Oct. 30, 2018) (citing EIA, Electric Power Annual, Table 4.1. Count of Electric Power Industry Power Plants, by Sector, by Predominant Energy Sources within Plant, 2007 through 2017, https://www.eia.gov/electricity/annual/html/epa_04_01.html), attached as Exhibit E to Comments of the Attorneys General of New York [et al.] on the Environmental Protection Agency’s Proposed Emission Guidelines for Greenhouse Gas

competitive or restructured power markets, investment decision making in those non-market settings is more likely to be driven by non-financial considerations.¹⁵⁷ For instance, EPA received public comments on the proposal that became the Current Standard that argued that developers may value coal-fired plants for purposes such as “stable fuel prices,” “fuel diversification,” and “site-specific jobs and economic development considerations.”¹⁵⁸ Additionally, EPA reviewed several utility resource plans that included coal-fired plants and other less cost-competitive generation options for the stated purpose of maintaining “fuel diversity.” Proposed Rule at 65,436; *see also* 2015 Preamble at 64,526, 64,563.

Non-economic considerations are not captured in EPA’s power-system forecast modeling, however. *See* Proposed Rule at 65,436. EPA reasonably “assumed that developers . . . were therefore willing to pay a premium” for baseload generators other than gas-fired plants, and designed the Current Standard such that “new coal-fired EGUs can still be part of the future fuel diversity mix.” *Id.* at 65,436. As confirmed in the Proposed Rule, nothing has changed since the 2015 rulemaking that should cause EPA to rule out the possibility of future investments in new, modified, or reconstructed coal-fired plants for “fuel diversity” or other reasons. *See id.* at 65,436.

In fact, since the 2015 rulemaking, the federal government has continued to anticipate and contemplate the construction of new coal-fired plants. For example, on November 13, 2018, the Department of Energy announced its intent to fund research to develop and promote “the coal plant of the future.”¹⁵⁹ The Department of Energy not only anticipates “[d]eployment of new coal plants” but also is actively soliciting proposals that “may ultimately culminate in the design,

Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program (Oct. 31, 2018), Docket ID EPA-HQ-OAR-2017-0355-24817.

¹⁵⁷ *Cf. id.* at 3-8, 13-17 (explaining that coal-fired plants that are publicly or cooperatively owned or governed by traditional cost-of-service regulation are more likely to undertake investments to prolong the plant’s life than merchant generators).

¹⁵⁸ Proposed Rule at 65,436. In 2015 EPA explained that the “affected industry itself urged the EPA to withdraw its original standard for all new fossil fuel-fired units in order to provide for the possibility of some additional new coal-fired generation capacity, See 79 FR at 1434. If such new sources were to be constructed, the promulgated standard would significantly reduce CO₂ emissions from such a source in comparison with a source (even an ultrasupercritical boiler) not meeting the standard.” 2015 RTC, Response 2.1-34, at 2-14. *See, e.g.*, Comments of National Mining Association to EPA, EPA-HQ-OAR-2011-0660-9952, at 17–18 (June 25, 2012) (“[U]tilities maintain resource diversity to ensure they are not overly exposed to the type of unforeseen and unforeseeable market changes that are inherent in the energy sector. For EPA to exclude coal . . . from utility resource portfolios . . . is imprudent in the extreme.”).

¹⁵⁹ *See* Off. of Fossil Energy, U.S. Dep’t of Energy, Energy Department Announces Intent to Fund Research that Advances the Coal Plants of the Future, Nov. 13, 2018, <https://www.energy.gov/fe/articles/energy-department-announces-intent-fund-research-advances-coal-plants-future>.

construction, and operation of a coal-based pilot-scale power plant.”¹⁶⁰ And in February 2018, President Trump signed into law a bipartisan budget bill that expanded a tax credit for carbon dioxide sequestration technology. *See* Bipartisan Budget Act of 2018, Pub. L. No. 115-123, § 41119, 132 Stat. 64, 120 (2018). EPA has no reasonable basis to change its assumption supporting the Current Standard and the Proposed Rule that industry may choose to invest in new coal-fired plants.

b. EPA acted reasonably to regulate the significant, plausible health and environmental risks of power plant CO₂ emissions.

As the Proposed Rule recognizes, even EPA’s best projections about the future cost-competitiveness of coal-fired plants rely on uncertain assumptions and estimates. Proposed Rule at 65,427. Although EPA expects it is unlikely developers would opt to construct a new coal-fired plant, there are nonetheless plausible future scenarios in which a new coal-fired plant could be cost-competitive with other generation options in the absence of an emission standard (for example, assuming unexpectedly high natural gas prices). *See* 2015 Regulatory Impact Analysis, 5-14 to 5-16. Comments that EPA received from industry and other stakeholders in the course of developing the Current Standard affirmed that it is prudent for EPA to consider those plausible, even if improbable, scenarios.¹⁶¹

Furthermore, considering less likely future scenarios that favor construction of new coal plants is consistent with administrative best practices and the protective goals of the Clean Air Act. “[T]he CO₂ emissions from even a single new coal-fired power plant may amount to millions of tons each year,” imposing considerable public health and environmental risks. Proposed Rule at 65,432. Regulation is a rational response to those significant risks. The risk-management rationale underlying EPA’s Current Standard continues to support EPA’s position that regulation of new coal-fired plants is warranted. Indeed, since EPA adopted the Current Standard, new research on climate trends and increasing evidence of the harmful impacts of climate change have further solidified the need for regulatory action to prevent and mitigate dangerous carbon emissions. *See* sections I.A and I.B, above. It is more urgent than ever that

¹⁶⁰ *Id.*; *see also* Off. of Fossil Energy, U.S. Dep’t of Energy, Energy Department Issues Request for Proposal for Conceptual Designs That Advance the Coal Plants of the Future, Dec. 7, 2018, <https://www.energy.gov/fe/articles/energy-department-issues-request-proposal-conceptual-designs-advance-coal-plants-2>.

¹⁶¹ *See, e.g.*, Comments of Edison Electric Institute to EPA, 7-8, 10-11, Docket ID EPA-HQ-OAR-2011-0660-9933 (June 25, 2012) (arguing that “there is no way to know with certainty that natural gas prices will not increase in the future” and it “could make economic and business sense to build new coal units in the future”); Comments of National Mining Association to EPA, 18, Docket ID EPA-HQ-OAR-2011-0660-9952 (June 25, 2012) (noting that “markets change, natural gas prices may increase, incentives to build new coal plants may return”); Comments of Alstom to EPA, Docket ID EPA-HQ-OAR-2013-0495-9033 (May 9, 2014) (“[R]eliance on EIA forecasts that no coal plants will be built in any event is precarious. EIA forecasts are a snapshot based on a set of assumptions and have consistently failed to see market fluctuations and interruptions.”).

EPA continues to protect human health and the environment from the risks of power-plant carbon emissions.

- c. **EPA has no basis for changing its interpretation of section 111 that significant contribution is based on the source category as a whole, not a particular number of new sources that may exist in the future.**

EPA's current position that significance under section 111(b)(1)(A)'s listing criteria is determined by looking at the source category as a whole, not just expected future sources, is correct. EPA would have no reasonable basis for reversing this legal position. As EPA explained in the 2015 rulemaking, "The cause or contribute criterion [of section 111(b)(1)(A)] relates to the amounts of pollutant a source category emits to the air pollutant which endangers public health or welfare. Fossil-fuel fired electricity generating units emit more CO₂ than any other source category – by a very wide margin. By any objective measure, this is a substantial contribution." 2015 RTC, Response 2.1-35, at 2-15. As described above in this section VI.C, nothing about this source category has materially changed since EPA issued the Current Standard.

Considering the source category as a whole under section 111(b)(1)(A) is the only rational approach under the Clean Air Act because a listing must occur before existing sources can be regulated at all under section 111(d). If, contrary to EPA's interpretation, the agency would only make a listing decision on the basis of whether pollution from *new* sources in that category were expected to endanger public health or welfare, then EPA might deprive itself (and states) of the ability to regulate *existing* sources under section 111(d), regardless of how much of a danger pollution from those existing sources posed. There is no reason to believe that Congress would have structured section 111 to achieve this absurd result. Furthermore, some existing sources would become subject to new source performance standards due to modification or reconstruction. It makes no sense to ignore those sources to focus exclusively on projected new sources.

In sum, there is no reason EPA should change its existing interpretations on the above questions in response to comments it solicits in footnote 25.

VII. EPA'S ECONOMIC ANALYSIS FAILS TO CONSIDER INCREASED ENVIRONMENTAL HARMS THAT WOULD RESULT FROM CHANGING THE EMISSION STANDARD IN THE EVENT THAT NEW COAL-FIRED PLANTS ARE BUILT. (C-28)

- A. **The proposed standard is arbitrary and capricious because EPA failed to consider an important aspect of the problem: the harms from increased CO₂ emissions under the Proposed Rule compared to the Current Standard.**

In contrast to its previous efforts to quantify the harms the Current Standard would avoid in the event that new coal-fired powers plant are built,¹⁶² EPA does nothing at all to analyze or quantify what harms would result from emissions of those plants operating under the Proposed Rule. EPA admits that the costs it does consider "do not account for any of the potential benefits

¹⁶² See 2015 Regulatory Impact Analysis, ch. 5.

of reduced criteria and GHG emissions due to the use of partial CCS.” Proposed Rule at 65,440/1.

In place of actual analysis, EPA makes the sweeping projection that the Proposed Rule “will work towards addressing this market failure by causing affected EGUs to begin to internalize the negative externality associated with CO₂ emissions.” 2018 Economic Impact Analysis, at 1-2. EPA provides no reason to believe that this is true, especially since later in the same document EPA contradicts itself, explaining that it proposes to set the emission standard at the level that it expects any new coal-fired plant to achieve even in the absence of Proposed Rule. *Id.* at 3-5 (explaining that “modeling demonstrates that all new sources covered by this proposal that are currently planned or projected to be constructed are capable of meeting the proposed standard without taking any additional action”).

Accordingly, EPA’s economic analysis avoids quantifying the potential harms from changing from the Current Standard to the Proposed Rule in the event that new coal-fired plants are built, ignoring a crucial aspect of the problem of climate change (discussed in sections I.A-I.B, above). *See American Lung Ass’n*, 134 F.3d 388, 392 (D.C. Cir. 1998) (failure to consider public health effects of rulemaking rendered EPA Administrator unable to fulfill duty under Clean Air Act); *State Farm*, 463 U.S. at 43.

B. In any future analysis, EPA should account for the actual harms of increased CO₂ emissions resulting from replacing the Current Standard with the Proposed Rule. (C-8)

As many of the States and Cities explained to EPA in their October 31, 2018, comment letter to EPA opposing its proposal to replace the Clean Power Plan, a proper evaluation of economic impacts of a regulation affecting CO₂ emissions must use an appropriate discount rate and properly take into account the social cost of carbon and co-benefits of CO₂ reduction.¹⁶³ EPA already developed very conservative metrics for these benefits in its 2015 Regulatory Impact Analysis, which could serve as a starting point for analysis of this proposal. The analysis should also take into account a discount rate below 3 percent and evaluate climate damages not captured by previous models.

In a calculation of the economic harms from replacing the Current Standard with the Proposed Rule, EPA must take into account a realistic quantitative assessment of the social cost of carbon, including international impacts, developed by the federal Interagency Working Group.¹⁶⁴ Using the best available methodologies and data, the Interagency Working Group

¹⁶³ Comments of the Attorneys General of New York [et al.] on the Environmental Protection Agency’s Proposed Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program, 127-38 (Oct. 31, 2018), Docket ID EPA-HQ-OAR-2017-0355-24817.

¹⁶⁴ In 2009 an interagency workgroup composed of members from six federal agencies and various White House offices was convened to improve the accuracy and consistency in how agencies value reductions in CO₂ emissions in regulatory impact analyses. The resulting range of values was based on estimates from three integrated assessment models applied to five socioeconomic and emissions scenarios, all given equal weight. To reflect differing expert

included impacts outside of the United States that affect our country in its calculations.¹⁶⁵ The Seventh Circuit Court of Appeals upheld this metric against the argument that impacts outside of the United States should be ignored, reasoning that the Department of Energy had reasonably identified carbon pollution as a “global externality,” and appropriately concluded that because “national energy conservation has global effects, . . . those global effects are an appropriate consideration when looking at national policy.” *Zero Zone, Inc. v. Dep’t of Energy*, 832 F.3d 654, 679 (7th Cir. 2016). Including international impacts is also in accord with the National Academy of Sciences’ recent conclusion that “[c]limate damages to the United States cannot be accurately characterized without accounting for consequences outside U.S. borders.”¹⁶⁶ EPA itself has long supported including these impacts in assessing the costs of climate change.¹⁶⁷

Furthermore, EPA must also consider the non-monetized costs of climate change that are not incorporated in the social cost of carbon models. Office of Management and Budget (OMB) Circular A-4 specifically requires that “[w]hen there are important non-monetary values at stake,

opinions about discounting, the present value of the time path of global damages in each model-scenario combination was calculated using discount rates of 5 percent, 3 percent, and 2.5 percent. National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, “Guidelines for Preparing Economic Analysis,” (Dec. 17, 2010) Section 7-2.

¹⁶⁵ See 2016 Technical Support Document Update of the Social Cost of Carbon for Regulatory Impact Analysis, available at: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf.

¹⁶⁶ Nat’l Academy of Sciences, Engineering, & Medicine, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* (2017), at 53.

¹⁶⁷ *Regulating Greenhouse Gas Emissions Under the Clean Air Act*, 73 Fed. Reg. 44,354, 44,415-16 (2008):

GHGs are global pollutants. Economic principles suggest that the full costs to society of emissions should be considered in order to identify the policy that maximizes the net benefits to society, i.e., achieves an efficient outcome Estimates of global benefits capture more of the full value to society than domestic estimates and can therefore help guide policies towards higher global net benefits for GHG reductions. Furthermore, international effects of climate change may also affect domestic benefits directly and indirectly to the extent U.S. citizens value international impacts (e.g., for tourism reasons, concerns for the existence of ecosystems, and/or concern for others); U.S. international interests are affected (e.g., risks to U.S. national security, or the U.S. economy from potential disruptions in other nations); and/or domestic mitigation decisions affect the level of mitigation and emissions changes in general in other countries (i.e., the benefits realized in the U.S. will depend on emissions changes in the U.S. and internationally). The economics literature also suggests that policies based on direct domestic benefits will result in little appreciable reduction in global GHGs (e.g., Nordhaus, 1995).

you should also identify them in your analysis,”¹⁶⁸ and instructs that agencies must “include a summary table that lists all the unquantified benefits and costs, and use your professional judgment to highlight (e.g., with categories or rank ordering) those that you believe are most important.”¹⁶⁹ In addition, OMB warned that “the most efficient alternative will not necessarily be the one with the largest quantified and monetized cost-benefit estimate.”¹⁷⁰

Social cost of carbon models do not account for various costs of climate change, including climate impacts on the following market sectors: agriculture, forestry and fisheries (including pests, pathogens and weeds, erosion, fires, and ocean acidification); ecosystem services (including biodiversity and habitat loss)); health impacts (including Lyme disease and respiratory illness from increased ozone pollution, pollen, and wildfire smoke). EPA’s neglect of these omitted damages, and its disregard of OMB Circular A-4, is arbitrary and capricious.

When EPA does calculate the economic harm from replacing the Current Standard with the Proposed Rule in the event that new coal-fired power plants are built, EPA should use a discount rate below 3 percent. In the context of climate change, where emissions today will have impacts for many centuries, an analysis that assumes 3 percent is the lowest discount rate that should be meaningfully considered is not rational. Using even a 3-percent discount rate leads to inequitable results when calculating the costs of potentially catastrophic events hundreds of years in the future. EPA made the case for why it should consider lower discount rates a decade ago:

There are reasons to consider even lower discount rates in discounting the costs of benefits of policy that affect climate change. First, changes in GHG emissions—both increases and reductions—are essentially long-run investments in changes in climate and the potential impacts from climate change. When considering climate change investments, they should be compared to similar alternative investments (via the discount rate). Investments in climate change are investments in infrastructure and technologies associated with mitigation; however, they yield returns in terms of avoided impacts over a period of one hundred years and longer. Furthermore, there is a potential for significant impacts from climate change, where the exact timing and magnitude of these impacts are unknown. These factors imply a highly uncertain investment environment that spans multiple generations. When there are important benefits or costs that affect multiple generations of the population, EPA and OMB allow for low but positive discount rates (e.g., 0.5–3% noted by U.S. EPA, 1–3% by OMB).

73 Fed. Reg. at 44,414. Also, a recent survey of experts showed that 62 percent believed that the appropriate discount rate should be lower than 2.5 percent.¹⁷¹

¹⁶⁸ OMB Circular A-4 at 3.

¹⁶⁹ *Id.* at 27.

¹⁷⁰ *Id.* at 2.

¹⁷¹ Expert Report, The Use of the Social Cost of Carbon in the Federal Proposal “Safer Affordable Fuel- Efficiency (SAFE) Vehicles Rule,” (attached to comments of California Air Resources Board, Docket ID EPA-HQ-OAR-2018-0283-5481) Maximilian Auffhammer, October 24, 2018, at 12. Also, the Office of Management and Budget has concluded that a

If and when EPA does analyze the economic impacts, in the event that a new coal-fired plant is built, of replacing the Current Standard with the Proposed Rule, it should include the above recommendations in its analysis.

VIII. CONCLUSION

EPA was correct to promulgate the Current Standard in 2015 to address the climate change crisis, and it should continue to leave those emission limits in place. EPA relied on a thorough factual record and proper legal analysis in that 2015 rulemaking. EPA fails in the Proposed Rule to justify reversing its well-considered 2015 findings, rendering the new proposal arbitrary and capricious and in violation of the Clean Air Act. The States and Cities urge EPA to withdraw the Proposed Rule and not finalize it.

Sincerely,

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Enclosures: Appendix A: Climate Change Impacts
Appendix B: Carbon Sequestration in State Statutes and Regulations

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discount rate of 7 percent is not appropriate for effects experienced on a long time horizon, such as climate change. *See* Guidelines for Preparing Economic Analysis, Section 6-15.

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Appendix A

Climate Change Impacts

Comments of the Attorneys General of California, Connecticut, Delaware, Illinois, Iowa, Maine, Maryland, Massachusetts, Minnesota (by and through its Minnesota Pollution Control Agency), New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, and the District of Columbia, the Maryland Department of the Environment, and the cities of Boulder, Chicago, Los Angeles, New York, Philadelphia, and South Miami, and Broward County

on

the Environmental Protection Agency's Proposed Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 83 Fed. Reg. 65,424 (Dec. 20, 2018)

Docket ID No. EPA-HQ-OAR-2013-0495

March 18, 2019

Our States and Cities have already begun to experience adverse impacts from climate change. Based on the overwhelming scientific evidence, those harms are likely to increase in number and severity unless aggressive steps are taken to reduce emissions of carbon dioxide and other greenhouse gases. Summarized below are some of those most significant threats being faced by our States and Cities.

California

Climate change's adverse effects have become impossible to ignore in California. The state weathered a historic five-year drought only to face record-setting fire seasons and a variety of other unprecedented phenomena increasingly harming the health and prosperity of Californians from all walks of life and all parts of the state, as described in more detail in a recent report of the California Air Resources Board.¹

Drought conditions beginning in 2012 left reservoirs across the state at record low levels, often no more than a quarter of their capacity. The Sierra snowpack—critical to California's water supply, tourism industry, and hydroelectric power—was the smallest in at least 500 years.² The resulting cutbacks threatened the livelihoods of farmers and fishermen alike. In the Central Valley, the drought cost California agriculture about \$2.7 billion and more than 20,000 jobs in 2015 alone.³ In addition, the drought led to land subsidence, due to reduced precipitation and increased groundwater pumping, and the death of 129 million trees throughout the state.⁴

Even prior to the drought, the U.S. Forest Service had found that California was at risk of losing 12 percent—over 5.7 million acres—of the total area of forests and woodlands in the state due to insects and disease thriving in a hotter climate.⁵ Several pine species are projected to lose around half of their basal area.⁶ And a majority of the ponderosa pine in the foothills of the central and southern Sierra Nevada Mountains has already died, killed by the western pine beetle and other bark beetles.⁷ The increasing threat from these insects is driven in large part by warmer

¹ See generally California Air Resources Board, *California's 2017 Climate Change Scoping Plan Update: The Strategy for Achieving California's 2030 Greenhouse Gas Target*, (Nov. 2017), https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

² See NOAA, National Centers for Environmental Information: "Multi-Century Evaluation of Sierra Nevada Snowpack," <https://www.ncdc.noaa.gov/news/multi-century-evaluation-sierra-nevada-snowpack>.

³ *California's 2017 Climate Change Scoping Plan Update*, *supra*, at 7.

⁴ U.S. Forest Service, *Record 129 Million Dead Trees in California* (2017), https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd566303.pdf.

⁵ *California's 2017 Climate Change Scoping Plan Update*, *supra*, at 7.

⁶ *Id.*

⁷ *Id.*

summer temperatures attributable to climate change.⁸ The very high levels of tree mortality led Governor Brown to issue an Emergency Proclamation on October 30, 2015, directing state agencies to identify and take action to reduce wildfire risk through the removal and use of the dead trees.⁹

Notwithstanding the Governor's Proclamation, the hotter, drier weather and millions of dead trees have increasingly accelerated the damage from wildfires. The 2017 season—the worst on record—killed dozens of people, destroyed thousands of homes, forced hundreds of thousands to evacuate, and burned more than half a million acres.¹⁰ Prior to 2017, the worst year on record was 2015. In between, California faced the most expensive wildfire in U.S. history, the Soberanes fire, which burned for three months in 2016 and cost more than \$250 million to put out.¹¹ Climate change is expected to make longer and more severe wildfire seasons “the new normal” for California.¹² Besides the immediate threats they pose to life and property, wildfires significantly impair both air quality (via smoke and ash that can hospitalize residents) and water quality (via the erosion of hillsides stripped of their vegetation).

Off the coast, rising ocean temperatures and ocean acidification have spurred toxic algal blooms, resulting in high levels of the neurotoxin domoic acid.¹³ This toxin has hit California's economically valuable Dungeness crab fishery particularly hard. From 2015 to 2017, domoic acid contamination forced California to close the fishery for parts of the season in order to protect consumers from serious health risks, with the 2015-16 season declared a federal disaster.¹⁴ Other fisheries have suffered a similar fate. The Dungeness crab fishery is expected to decline significantly in the future as acidification increases.¹⁵ In addition, high levels of domoic

⁸ Jeffry B. Mitton and Scott M. Ferrenberg, *Mountain Pine Beetle Develops an Unprecedented Summer Generation in Response to Climate Warming*, THE AMERICAN NATURALIST, Vol. 179, No. 5 (May 2012).

⁹ “Proclamation of a State of Emergency,” https://www.gov.ca.gov/wp-content/uploads/2017/09/10.30.15_Tree_Mortality_State_of_Emergency.pdf.

¹⁰ Lauren Tierney, *The Grim Scope of 2017's California Wildfire Season Is Now Clear. The Danger's Not Over.*, WASH. POST (Jan. 4, 2018), <https://www.washingtonpost.com/graphics/2017/national/california-wildfires-comparison/>.

¹¹ Lyndsey Gilpin, *The 10 Most Expensive Wildfires in the West's History*, HIGH COUNTRY NEWS (Oct. 5, 2016), <https://www.hcn.org/articles/the-10-most-expensive-wildfires-in-the-west-s-history>.

¹² California Department of Forestry and Fire Protection, *California's Forests and Rangelands: 2010 Assessment*, Ch. 3-7 (2010).

¹³ S. Morgaine McKibben et al., *Climatic Regulation of the Neurotoxin Domoic Acid*, 114 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 2 (2007).

¹⁴ See Tara Duggan, *Toxin again an issue as Dungeness crab season nears*, S.F. CHRONICLE (Oct. 30, 2017), <https://www.sfchronicle.com/food/article/Dungeness-crab-season-could-be-delayed-again-by-12318483.php>; Mary Callahan, *California's crab fleet awaits share of \$200 million in disaster relief*, SANTA ROSA PRESS-DEMOCRAT (Feb. 15, 2018), <http://www.pressdemocrat.com/news/7996795-181/californias-crab-fleet-awaits-share?sba=AAS>.

¹⁵ Marshall, K.N. et al., *Risks of Ocean Acidification in the California Current Food Web and Fisheries: Ecosystem Model Projections*, 21 GLOB. CHANGE BIOL. 4 (2017).

acid are poisoning marine mammals, and have been linked to reproductive failure (including high rates of miscarriage and premature birth) among California sea lions.¹⁶

California's many miles of coastline, particularly coastal bluffs, make it uniquely vulnerable to sea-level rise and more intense storms. Even if storms do not become more intense or frequent, sea-level rise itself will magnify the adverse impact of any storm surge and high waves on the California coast. Some observational studies report that the largest waves are already getting higher and winds are getting stronger.¹⁷ California is likely to face greater than average sea-level rise, because of gravitational forces and the rotation of the Earth. Recent projections indicate that if no significant greenhouse gas mitigation efforts are taken, the San Francisco Bay Area may experience sea level rise between 1.6 to 3.4 feet, and in an extreme scenario involving the rapid loss of the Antarctic ice sheet, sea levels along California's coastline could rise up to 10 feet by 2100.¹⁸

In addition to damage to the physical environment, increased temperatures California will experience due to climate change will put the health of state residents at risk. Increased hospitalizations for multiple diseases, including cardiovascular disease, ischemic heart disease, ischemic stroke, respiratory disease, pneumonia, dehydration, heat stroke, diabetes, and acute renal failure are associated with increases in same-day temperature.¹⁹ Such temperature increases have also been found to be associated with increased risk of preterm delivery²⁰ and stillbirths.²¹ Recent California studies suggest increased mortality risk not only with extreme heat, but also with increasing ambient temperature.²²

¹⁶ T. Goldstein et al., *The Role of Domoic Acid in Abortion and Premature Parturition of California Sea Lions (Zalophus californianus) on San Miguel Island, California*, JOURNAL OF WILDLIFE DISEASES. 45(1): 91-108 (2009).

¹⁷ National Research Council of the National Academy of Sciences, *Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present, and Future*. National Academies Press (2012).

¹⁸ Griggs, G, Árvai, J, Cayan, D, DeConto, R, Fox, J, Fricker, HA, Kopp, RE, Tebaldi, C, Whiteman, EA (California Ocean Protection Council Science Advisory Team Working Group). *Rising Seas in California: An Update on Sea-Level Rise Science*. California Ocean Science Trust, April 2017.

¹⁹ Green R, Basu R, Malig B, Broadwin R, Kim J and Ostro B (2010). *The Effect of Temperature on Hospital Admissions in Nine California Counties*. INTERNATIONAL JOURNAL OF PUBLIC HEALTH 55(2): 113-121. See also Basu R, Pearson D, Malig B, Broadwin R and Green S (2012). *The effect of elevated ambient temperature on emergency room visits in California*. EPIDEMIOLOGY 23(6):813-20; Sherbakov T, Malig B, Guirguis K, Gershunov A, Basu R. (2018) *Ambient temperature and added heat wave effects on hospitalizations in California from 1999 to 2009*. ENVIRON RES. 160:83-90.

²⁰ Basu R, Malig B and Ostro B (2010). *High ambient temperature and the risk of preterm delivery*. AM J EPIDEMIOLOGY 172(10): 1108-1117.

²¹ Basu R, Sarovar V, Malig BJ (2018) *Association Between High Ambient Temperature and Risk of Stillbirth in California*. AM J EPIDEMIOL. 183(10):894-901.

²² Basu R and Ostro BD (2008a). *A multicounty analysis identifying the populations vulnerable to mortality associated with high ambient temperature in California*. AM J EPIDEMIOL. 168(6): 632-637; Basu R, Feng W and Ostro B (2008b). *Characterizing temperature and mortality in nine California counties, 1999-2003*. EPIDEMIOLOGY 19(1): 138 -145; Basu R and Malig B (2011). *High ambient*

California 2018 Supplement

In 2018, the State of California produced two substantial reports on the impacts of climate change in California, which incorporate the latest scientific research on the impacts of climate change in California.

The first report, published May 2018 titled “*Indicators of Climate Change in California*” examines thirty-six separate indicators and reflects the contributions of dozens of scientists from California’s universities, and state agencies, as well as the U.S. National Oceanic and Atmospheric Administration and the U.S. Department of Energy’s Lawrence Berkeley National Laboratory.²³ A copy of the full “Indicators” report is included in the attachments to the States’ comments.

The second report, published August 2018 titled “*California’s Fourth Climate Assessment*” includes thirty-three papers from State-funded research, and eleven papers from externally funded researchers, as well as regional summaries and a statewide summary of climate vulnerabilities, and a key findings paper.²⁴ A copy of selected research papers and the regional and statewide summaries and key findings reports are included in the attachments to the States’ comments.

Key findings from those reports and other sources include the following:

Temperature Changes and Air Quality Impacts

“Since 1895, annual average air temperatures have increased throughout the state, with temperatures rising at a faster rate beginning in the 1980s. The last four years were notably warm, with 2014 being the warmest on record, followed by 2015, 2017, and 2016. Temperatures at night have increased more than during the day: minimum temperatures (which generally occur at night) increased at a rate of 2.3 degrees Fahrenheit (°F) per century, compared to 1.3°F per century for maximum temperatures.”²⁵

temperature and mortality in California: Exploring the roles of age, disease, and mortality displacement. ENVIRONMENTAL RESEARCH 111(8): 1286-1292.

²³ See Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2018). *Indicators of Climate Change in California*. Available at www.oehha.ca.gov/climate-change/document/indicators-climate-change-california (last visited October 24, 2018) (hereinafter “California Climate Indicators 2018”).

²⁴ See California Natural Resources Agency, *California’s Fourth Climate Change Assessment* (2018), available at www.ClimateAssessment.ca.gov (last visited October 24, 2018) (hereinafter “California 4th Assessment”).

²⁵ California Climate Indicators 2018 at S-4.

“Extremely hot days and nights — that is, when temperatures are at or above the highest 2 percent of maximum and minimum daily temperatures, respectively — have become more frequent since 1950. Both extreme heat days and nights have increased at a faster rate in the past 30 years. Heat waves, defined as five or more consecutive extreme heat days or nights, are also increasing, especially at night. Nighttime heat waves, which were infrequent until the mid-1970s, have increased markedly over the past 40 years.”²⁶

In addition, rising temperatures “could lead to increases in ground-level ozone and reduce the effectiveness of emission reductions taken to achieve air quality standards....”²⁷

“A recent detailed analysis suggests that adoption of low-carbon energy in California to reduce GHG emissions 80 percent below 1990 levels would lead to a 55 percent reduction in air pollution mortality rates relative to 2010 levels (Zapata et al., 2018). These public health improvements have a value of \$11-20 billion/year in California (Zapata et al., 2018).”²⁸

Human Health Impacts

Climate change poses direct and indirect risks to public health, as people will experience earlier death and worsening illnesses.

“Nineteen heat-related events occurred from 1999 to 2009 that had significant impacts on human health, resulting in about 11,000 excess hospitalizations. However, the National Weather Service issued Heat Advisories for only six of the events. Heat-Health Events (HHEs), which better predict risk to populations vulnerable to heat, will worsen drastically throughout the state: by midcentury, the Central Valley is projected to experience average Heat-Health Events that are two weeks longer, and HHEs could occur four to ten times more often in the Northern Sierra region.”²⁹

“The 2006 heat wave killed over 600 people, resulted in 16,000 emergency department visits, and led to nearly \$5.4 billion in damages. The human cost of these events is already immense, but research suggests that mortality risk for those 65 or older could increase ten-fold by the 2090s because of climate change.”³⁰

²⁶ *Id.* at S-5.

²⁷ California’s Fourth Climate Change Assessment, California’s Changing Climate 2018: Statewide Summary Report at 40 (Aug. 2018), *available at* <http://www.climateassessment.ca.gov/state/docs/20180827-StatewideSummary.pdf>. (hereinafter “California Statewide Summary”).

²⁸ *Id.* at 71.

²⁹ *Id.* at 10.

³⁰ *Id.*

Environmental Justice Impacts

“Multiple studies of vulnerability and climate impacts indicate that existing inequities can be exacerbated by climate change. For example, the consequences of climate-related water impacts are particularly acute for communities already dealing with a legacy of inequalities. A recent study on drought and equity in California found that low-income households, people of color, and communities already burdened with environmental pollution suffered the most severe impacts caused by water supply shortages and rising cost of water (Feinstein et al., 2017). In a report prepared as part of the Fourth Assessment, Ekstrom et al. (2018) found that while all water districts faced similar challenges during the drought, small water districts (defined as those serving less than 10,000 people or less than approximately 3,300 connections) were less likely to have the resources and capacity to overcome those challenges. These districts are most likely to serve small, rural communities in California. Furthermore, for marginalized populations in rural areas of the state, agricultural actions in response to the drought, including increases in groundwater pumping and crop choices, are increasing and reshaping their vulnerability to drought and water shortage (Greene, 2018).³¹

“Inequities not only exist in varying exposures to climate risk, but also in the availability and implementation of potential adaptation or resilience solutions. Recent research analyzed differences in tree canopy, an important tool for adapting to the effects of extreme heat, at the census block group scale in coastal Los Angeles and found disparities between canopy in high-income and low-income neighborhoods (Locke et al., 2017). This disparity can have implications for communities because of the benefits tree canopy provides in reducing the negative effects of extreme heat events. A study prepared for the Fourth Assessment provides one of the first estimates of these benefits in one location (Taha et al., 2018).”³²

Tribal and Indigenous Communities Impacts

“Tribes and Indigenous communities in California face unique challenges under a changing climate. Tribes maintain cultural lifeways and rely on traditional resources (e.g., salmon fisheries) for both social and economic purposes. However, tribes are no longer mobile across the landscape. For many tribes in California, seasonal movement and camps were a part of living with the environment. Today these nomadic options are not available or are limited. This is the result of Euro-American and U.S. policy and actions and underpins several climate vulnerabilities. Tribes with reservations/Rancherias/allotments are vulnerable to climate change in a specific way: tribal lands are essentially locked into fixed geographic

³¹ California Statewide Summary at 36-37.

³² *Id.* at 37.

locations and land status. Only relatively few tribal members are still able to engage in their cultural traditions as livelihoods.”³³

Precipitation and Water Supply Impacts

“California has the highest variability of year-to-year precipitation in the contiguous United States.”³⁴ By 2050, “the average water supply from snowpack is projected to decline by 2/3 from historical levels.”³⁵

“Statewide precipitation has become increasingly variable from year to year. In seven of the last ten years, statewide precipitation has been below the statewide average (22.9 inches). In fact, California’s driest consecutive four-year period occurred from 2012 to 2015. In recent years, the fraction of precipitation that falls as rain (rather than snow) over the watersheds that provide most of California’s water supply has been increasing — another indication of warming temperatures.”³⁶

“Spring snowpack, aggregated over the Sierra Nevada and other mountain catchments in central and northern California, declines substantially under modeled climate changes (Figure 6). The mean snow water equivalent (SWE) declines to less than two-thirds of its historical average by 2050, averaged over several model projections under both RCP 4.5 and 8.5 scenarios. By 2100, SWE declines to less than half the historical median under RCP 4.5, and less than one-third under RCP 8.5. Importantly, the decline in spring snowpack occurs even if the amount of precipitation remains relatively stable over the central and northern California region; the snow loss is the result of a progressively warmer climate. Furthermore, while the models indicate that strong year-to-year variation will continue to occur, the likelihood of attaining spring snowpack that reaches or exceeds historical average is projected to diminish markedly (Pierce et al., 2018) (Figure 6).”³⁷

Agriculture Impacts

“Agricultural production could face climate-related water shortages of up to 16% in certain regions. Regardless of whether California receives more or less annual precipitation in the

³³ *Id.* at 10.

³⁴ *Id.* at 24.

³⁵ California’s Fourth Climate Change Assessment, California’s Changing Climate 2018: A Summary of Key Findings from California’s Fourth Climate Change Assessment 6 (Aug. 2018), available at <http://www.climateassessment.ca.gov/state/docs/20180827-SummaryBrochure.pdf>. (hereinafter “California Key Findings”) at 5.

³⁶ California Climate Indicators at S-5.

³⁷ California Statewide Summary at 27.

future, the state will be dryer because hotter conditions will increase the loss of soil moisture.”³⁸

“Winter chill has been declining in certain areas of the Central Valley. This is the period of cold temperatures above freezing but below a threshold temperature needed by fruit and nut trees to become and remain dormant, bloom, and subsequently bear fruit. When tracked using “chill hours,” a metric used since the 1940s, more than half the sites studied showed declining trends; with the more recently developed “chill portions” metric, fewer sites showed declines.”³⁹

“[I]t is evident from recent droughts that agricultural production will be challenged by water shortages, higher temperatures, changing atmospheric conditions, and conversion of agricultural land to developed uses (Medellín-Azuara et al., 2018; Wilson et al., 2017). Agriculture is the economic foundation for many of California’s communities, particularly rural communities where other employment opportunities are limited. Roughly 6.7 percent of jobs statewide are generated by farms and farm processing, and in the Central Valley the figure is much higher (22 percent) (UC Agricultural Issues Center, 2012). This means that climate change impacts to agriculture, and even nuanced impacts such as shifting cropping patterns, may create hardships in the rural communities where agriculture is foundational. Different crops have different labor demands (Medellín-Azuara et al., 2016), and shifting crop patterns may result in changes in employment throughout the agricultural sector (Greene, 2018; Villarejo, 1996). A Fourth Assessment study found that in the 2012-2016 drought, to access higher market prices and compensate for the higher cost of water, many farms switched to higher value crops, for which cultivation and harvesting could be largely automated— leaving agricultural workers with employment shortages beyond the drought (Greene, 2018). A report by the University of California found that in 2016, the drought resulted in a \$603 million loss to the economy and the loss of 4,700 jobs due to the impacts on agriculture (Medellín-Azuara et al., 2016).”⁴⁰

Forest Impacts

A new paper published on October 18, 2018, estimates that “human-caused climate change caused over half of the documented increase in fuel aridity since the 1970s and doubled the cumulative forest fire area since 1984,” contributing an additional 4.2 million ha [hectares] of forest fire.⁴¹ As the paper notes, “[i]ncreased forest fire activity across the western United States

³⁸ *Id.*

³⁹ California Climate Indicators at S-5.

⁴⁰ California Statewide Summary at 59.

⁴¹ John T. Abatzoglou and A. Park Williams, Impact of Anthropogenic Climate Change on Wildfire Across the Western U.S. Forests, *Proceedings of the National Academy of Science*, vol. 113, no.

in recent decades has contributed to widespread forest mortality, carbon emissions, periods of degraded air quality and substantial fire suppression expenditures.”⁴²

“A changing climate combined with anthropogenic factors has already contributed to more frequent and severe forest wildfires in the western U.S. as a whole (Abatzoglou & Williams, 2016; Mann et al., 2016; Westerling, 2016).”⁴³

“One Fourth Assessment model suggests large wildfires (greater than 25,000 acres) could become 50% more frequent by the end of century if emissions are not reduced. The model produces more years with extremely high areas burned, even compared to the historically destructive wildfires of 2017 and 2018.”⁴⁴

“By the end of the century, California could experience wildfires that burn up to a maximum of 178% more acres per year than current averages.”⁴⁵ Increased wildfire smoke will also lead to more respiratory illness.⁴⁶

In addition, the changes in climate make trees more vulnerable to pest infestations.

“Moisture stress in conifer forests enhances tree vulnerability to insect infestation, particularly by bark beetles (Anderegg et al., 2015; Bentz et al., 2010; Berryman, 1976; Gaylord et al., 2013; Hart et al., 2014; Kolb et al., 2016; Raffa et al., 2008). Between 2010 and 2017, an estimated 129 million trees have died (Young et al., 2017). Bark beetle outbreaks may be promoted by warming for multiple reasons (Bentz et al., 2010). Warming may promote successful beetle overwintering (Weed et al., 2015) and may also promote earlier timing of adult emergence and flight in spring/early summer, which may enable beetles to increase the frequency at which they can mate, lay eggs, and emerge as adults (Bentz et al., 2016).”⁴⁷

Drought and Land Subsidence Impacts

“The recent 2012-2016 drought was exacerbated by unusual warmth (Williams, Seager, et al., 2015), and disproportionately low Sierra Nevada snowpack levels (Dettinger & Anderson, 2015). This drought has been described as a harbinger of projected dry spells in

42 (Oct. 18, 2018), *available at* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5081637/pdf/pnas.201607171.pdf>.

⁴² *Id.*

⁴³ California Statewide Summary at 28.

⁴⁴ California Key Findings at 6.

⁴⁵ *Id.*

⁴⁶ *Id.* at 8.

⁴⁷ California Statewide Summary at 64.

future decades, whose impacts will likely be worsened by increased heat (Mann & Gleick, 2015). A very wet winter in 2016-2017 followed this drought, a further indication of potential continued climate volatility in the future (Berg & Hall, 2015; Polade, et al., 2017; Swain et al., 2018).”⁴⁸

“Warming air temperatures throughout the 21st century will increase moisture loss from soils, which will lead to drier seasonal conditions even if precipitation increases (Thorne et al., 2015). Warming air temperatures also amplify dryness caused by decreases in precipitation (Ault et al., 2016; Cayan et al., 2010; Diffenbaugh et al., 2015). These changes affect both seasonal dryness and drought events. Climate projections from the previous and present generation of GCMs (e.g. Pierce et al., 2014; Swain et al., 2018) show that seasonal summer dryness in California may become prolonged due to earlier spring soil drying that lasts longer into the fall and winter rainy season. The extreme warmth during the drought years of 2014 and 2015 intensified some aspects of the 2012-2016 drought (Griffin & Anchukaitis, 2014; Mao et al., 2015; Stephenson et al., 2018; Williams, Seager, et al., 2015) and may be analogous for future drought events (Diffenbaugh et al., 2015; Mann & Gleick, 2015; Williams, Seager, et al., 2015).”⁴⁹

In addition, a “secondary, but large, effect of droughts is the increased extraction of groundwater from aquifers in the Central Valley, primarily for agricultural uses. The pumping can lead to subsidence of ground levels, which around the San Joaquin-Sacramento Delta has been measured at over three-quarters of an inch per year.”⁵⁰

“This subsidence compounds the risk that sea-level rise and storms could cause overtopping or failure of the levees, exposing natural gas pipelines and other infrastructure to damage or structural failure. At this rate of subsidence, the levees may fail to meet the federal levee height standard (1.5 ft. freeboard above 100-year flood level) between 2050-2080, depending on the rate of sea-level rise.”⁵¹

Sea-Level Rise, Coastal Erosion and Infrastructure Impacts

“Along the California coast, sea levels have generally risen. Since 1900, mean sea level has increased by about 180 millimeters (7 inches) at San Francisco and by about 150 millimeters (6 inches) since 1924 at La Jolla. In contrast, sea level at Crescent City has declined by about 70 millimeters (3 inches) since 1933 due to an uplift of the land surface from the movement

⁴⁸ *Id.* at 13.

⁴⁹ *Id.* at 26.

⁵⁰ *Id.* at 14.

⁵¹ California Statewide Summary at 12.

of the Earth's plates. Sea level rise threatens existing or planned infrastructure, development, and ecosystems along California's coast."⁵²

"If emissions continue at current rates, Fourth Assessment model results indicate that total sea-level rise by 2100 is expected to be 54 inches, almost twice the rise that would occur if greenhouse gas emissions are lowered to reduce risk."⁵³

"31 to 67% of Southern California beaches may completely erode by 2100 without large-scale human interventions."⁵⁴

"Flooding from sea-level rise and coastal wave events leads to bluff, cliff, and beach erosion, which could affect large geographic areas (hundreds of kilometers). In research conducted for the Fourth Assessment, Erikson et al. (2018) found that if a 100-year storm occurs under a future with 2m (6.6 feet) of SLR, resultant flooding in Southern California could affect 250,000 people and lead to damages of \$50 billion worth of property and \$39 billion worth of buildings."⁵⁵

In addition, airports in major urban areas will be susceptible to major flooding from sea-level rise and storm surge by 2040-2080, and 370 miles of coastal highway will be susceptible to coastal flooding by 2100.⁵⁶

Ocean Acidity and Health Impacts

"Increasing evidence shows that climate change is degrading California's coastal and marine environment. In recent years, several unusual events have occurred along the California coast and ocean, including a historic marine heat wave, record harmful algal bloom, fishery closures, and a significant loss of northern kelp forests."⁵⁷

In addition:

"[o]cean acidification ... is predicted to occur especially rapidly along the West Coast (e.g., Gruber et al., 2012). Ocean acidification presents a clear threat to coastal communities through its significant impacts on commercial fisheries and farmed shellfish (Ekstrom et al., 2015) as well as to ocean ecosystems on a broader scale. Ocean acidification affects many shell-forming species, including oysters, mussels, abalone, crabs, and the microscopic

⁵² California Climate Indicators at S-7.

⁵³ California Key Findings, at 6.

⁵⁴ *Id.* at 15.

⁵⁵ California Statewide Summary at 31.

⁵⁶ *Id.* at 54-55.

⁵⁷ *Id.* at 12.

plankton that form the base of the oceanic food chain (Kroeker et al., 2013; Kroeker et al., 2010). Significant changes in behavior and physiology of fish and invertebrates due to rising CO₂ and increased acidity have already been documented (e.g., Hamilton et al., 2017; Jellison et al., 2017; Kroeker et al., 2013; Munday et al., 2009). Species vulnerable to ocean acidification account for approximately half of total fisheries revenue on the West Coast (Marshall et al., 2017).”⁵⁸

Connecticut

In April 2010, the Governor’s Steering Committee on Climate Change produced a report that predicted the impact of climate change on Connecticut’s agriculture, infrastructure, natural resources and public health.⁵⁹ In general the report concluded that the impact of climate change on these four areas would be largely negative; Connecticut crops such as maple syrup, apple and pear production, and shellfish will suffer; infrastructure to control coastal flooding and storm water could be substantially damaged; rare habitats and critical species face elimination; and Connecticut’s public health, particularly of the most vulnerable communities, is threatened by a decrease in air quality, extreme heat and the favorable conditions for increased disease.

The Connecticut Institute for Resilience and Climate Adaptation or CIRCA, an institute housed at the University of Connecticut, has projected a rise in sea level of approximately twenty inches by 2050. In response to this latest analysis, Governor Malloy signed Public Act 18-82, *An Act Concerning Climate Change Planning and Resiliency*, into law which requires state and federally funded projects to plan for a scenario of 50 centimeters of sea level rise by 2050, ensuring the success of future projects undertaken in the state, the prudence of state investments, and the safety of those residing on or near the shoreline. In addition to preparations for the imminent rise in sea level, Public Act 18-82 sets an interim target of a 45% reduction in greenhouse gas emissions from a 2001 baseline by 2030, ensuring Connecticut remains on a path to achieve an 80% reduction in emissions by 2050 as mandated under the state’s Global Warming Solutions Act.

Observed Change

Connecticut has already begun to experience the severe consequences of climate change induced by unchecked, increasing GHG emissions. Between 1895 and 2011, temperatures in the Connecticut increased by almost 2 °F (0.16 °F per decade), and precipitation increased by

⁵⁸ *Id.* at 66-67.

⁵⁹ Adaptation Subcommittee to the Governor’s Steering Committee on Climate Change, *The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health* (2010), available at <http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf>.

approximately five inches, or more than 10% (0.4 inches per decade).⁶⁰ Between 1980 and 2018, average annual temperature in Connecticut has risen by over 2° F. Over the same period, winter temperatures have warmed by 3° F.

The Northeast has experienced a greater recent increase in extreme precipitation than any other region in the United States; between 1958 and 2010, Connecticut saw more than a 70% increase in the amount of precipitation falling in very heavy events. In 2011 Hurricane Irene caused power outages affecting 754,000 customers and over \$1 billion in damage, and in 2012 Hurricane Sandy caused power outages affecting more than 600,000 customers and over \$360 million in damage. The latter forced thousands of Connecticut residents evacuate, saw thousands apply for FEMA assistance, damaged roads and infrastructure, and took nine days for utilities to restore power.⁶¹ Many of Connecticut's coastal communities and assets remain at risk to more frequent future storm events exacerbated by climate change.

Projections

Connecticut is highly vulnerable to changes in mean and extreme climate due to regional characteristics like a dense population and aging infrastructure. In conservative estimates, climate projections for Connecticut robustly indicate that annual mean temperature will rise by 5-10°F by the end of the 21st Century.

Mean annual precipitation is also likely to increase, particularly in winter and spring seasons, contributing to increased flooding risk through the region. Additionally, weather and climate extremes are projected to be more frequent and intense which will impact both natural and socioeconomic sectors. As temperatures increase along the coast, humidity will also rise, resulting in amplified heat stress during summer months. For inland areas, drought events will become more severe and longer-lived, causing increased competition for limited water resources, agricultural crop damage, ecosystem stress, and risk of wildfire. Communities in Connecticut should expect that coastal flooding intensity and frequency to increase in coming decades due to accelerating trends in coastal erosion, extreme precipitation, and storms.

Sea Level

Direct and remotely sensed measurements of sea level have shown that the annual mean level of the ocean surface is rising. In the Northeast, coastal flooding has increased due to approximate one foot rise in sea level since 1900. This rate of sea level rise exceeds the global average of approximately eight inches, due primarily to land subsidence and thermal expansion

⁶⁰ Horton, R., Yohe, G., Easterling, W., Kates, R., Matthias, R., Sussman, E., Whelchel, A., Wolfe, D., and Lipschultz, F. (2014). Ch. 16: Northeast. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 16-1-nn.

⁶¹ Burgeson, John, *Rising Above the Tide: 5 Years Since Sandy*, CTPost, (Oct. 28, 2017), <https://www.ctpost.com/local/article/Rising-above-the-tide-5-years-since-Sandy-12313727.php>

(of ocean water) along the Northeastern coast. In moderately conservative estimates, sea level rise along the Connecticut coast is projected to be ~0.76 ft (0.23 meters) higher than 2000 levels by 2050.⁶² And according to a report released in late March 2018 by the Connecticut Institute for Climate and Resilience (CIRA), sea level rise is anticipated to rise by 2 feet by 2050 and over 3 feet by 2100.⁶³ This will strongly impact the many coastal communities and businesses in Connecticut.

Delaware

As a low-lying state with 381 miles of coastline, Delaware is vulnerable to coastal storms, sea level rise, and flooding exacerbated by climate change. Sea levels around Delaware have already risen 13 inches this century.⁶⁴ This means that storm surges come further inland and coastal towns flood more frequently, jeopardizing infrastructure, and leading to costly repairs. Towns like Slaughter Beach are partnering with the state to build climate adaption plans, recognizing that these events will only get worse and more expensive. As climate change exacerbates sea level rise, over 17,000 homes and almost 500 miles of roadway in Delaware are at risk of permanent inundation from sea level rise by the end of the century.⁶⁵

In addition, rising temperatures and extreme heat events as a result of climate change threaten public health and especially Delaware's most vulnerable citizens – young children, the elderly, outdoor workers, and individuals with underlying health conditions. Extreme heat days and extended heat waves can exacerbate poor air quality and unhealthy outdoor conditions, especially in urban areas like Wilmington. Extreme heat, saltwater intrusion from sea level rise, and changes in precipitation also threaten Delaware's \$8 billion agricultural industry, which is strongly ingrained in both the state's economy and culture.

⁶² O'Donnell, J., *Sea Level Rise in Connecticut*. Draft Report, Connecticut Institute for Resilience and Climate Adaptation (March 27, 2018), *available at* https://circa.uconn.edu/wp-content/uploads/sites/1618/2017/10/SeaLevelRiseConnecticutFinalDraft-Posted-3_27_18.pdf.

⁶³ See <https://circa.uconn.edu/2018/03/27/sea-level-rise-projections-for-the-state-of-connecticut-webinar-recording-available/>.

⁶⁴ Callahan, John A., Benjamin P. Horton, Daria L. Nikitina, Christopher K. Sommerfield, Thomas E. McKenna, and Danielle Swallow, *Recommendation of Sea-Level Rise Planning Scenarios for Delaware: Technical Report*, prepared for Delaware Department of Natural Resources and Environmental Control (DNREC) Delaware Coastal Programs (2017), *available at* <http://www.dgs.udel.edu/sites/default/files/projects-docs/de%20slr%202017%20technical%20report%20final.pdf>

⁶⁵ DNREC, *Preparing for Tomorrow's High Tide: Sea-Level Rise Vulnerability Assessment for the State of Delaware. Technical Report*, Prepared for the Delaware Sea Level Rise Advisory Committee by the Delaware Department of Environmental Control (2012), *available at* <http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentForWeb.pdf>.

Illinois

Climate change is affecting Illinois in a number of ways—both by fundamentally altering the state’s environment in ways never seen before and by intensifying well-recognized weather hazards. The fundamental changes can be seen in Illinois’ farming industry and in the state’s greatest environmental asset, Lake Michigan.

The farming sector is particularly vulnerable to extreme precipitation caused by climate change. 2012 was Illinois’ third driest summer on record. The very next year, heavy rainfall caused flooding in parts of the state that, together with the wettest January-to-June period ever recorded in Illinois, forced farmers to delay planting and lose revenue.⁶⁶ Heat waves during the crop pollination season may reduce future yield: hotter weather and altered rain patterns could cause 15% loss in the next 5 to 25 years and up to a 73% average loss by the end of the next century.⁶⁷ Milder winters will lead to more weeds, insects, and diseases surviving throughout winter, also hurting yield and quality.⁶⁸

Climate disruption also contributes to whipsawing water levels on Lake Michigan. In January 2013, the lake fell to an all-time low water level. In 2015, it climbed to its highest level since 1998, the second-largest recorded gain over a 24-month span.⁶⁹ Rapidly swinging water levels hurt the commercial shipping industry, recreational boaters, wildlife, and beach-goers. For example, for every inch the lake loses, a freighter must forgo 270 tons of cargo. High water erodes beaches and damages property.⁷⁰

Climate change has already turned up the volume on well-recognized catastrophic extreme weather events, causing stronger storms, increased precipitation, and higher average temperatures. In recent years, the state has been struck by deadly tornadoes in November 2013 and the 2014 polar vortex.⁷¹

Illinois also suffers from frequent flooding, and climate change has and will cause the frequency and strength of these floods to increase. For instance, flooding caused by increased

⁶⁶ University of Illinois–Institute of Government & Public Affairs, *Preparing for Climate Change in Illinois: An Overview of Anticipated Impacts*, <https://igpa.uillinois.edu/sites/igpa.uillinois.edu/files/reports/Preparing-for-Climate-Change-in-Illinois.pdf> (last visited Oct. 11, 2018).

⁶⁷ *Id.*

⁶⁸ *Id.*

⁶⁹ Tony Briscoe, *Lake Michigan Water Levels Rising at Near Record Rate*, CHICAGO TRIBUNE (July 12, 2015), available at <http://www.chicagotribune.com/news/local/breaking/ct-lake-michigan-water-levels-met-20150710-story.html>.

⁷⁰ *Id.*

⁷¹ National Weather Service, *Historic Tornado Outbreak of November 17, 2013*, <https://www.weather.gov/ilx/17nov13> (last visited Oct. 11, 2018); National Weather Service, *The Bitterly Cold Air of January 27-28, 2014*, <https://www.weather.gov/lot/2014jan28> (last visited Oct. 11, 2018).

precipitation causes dramatic damage to the lives and property of Illinois residents; this toll will increase as climate change intensifies. For example, in 2009, a freight train carrying ethanol derailed in Cherry Valley, Illinois due to washout of train tracks following heavy rains.⁷² Fourteen of the tanker cars carrying ethanol caught fire, killing a woman in her car waiting for the train to pass. Seven other people were injured and about 600 nearby homes were evacuated.⁷³ A few days later, a 54-mile-long fish kill occurred on the Rock River when ethanol that was not consumed by the fire flowed downstream, killing over 70,000 fish.⁷⁴

CHERRY VALLEY TRAIN DERAILMENT



Image from Rockford Register Star

In another instance, a major flood struck Jo Daviess County in northwestern Illinois in 2011 after 15 inches of rain fell during a 12-hour time period. The flood waters caused extensive damage to roads and train tracks and at least one fatality.⁷⁵ Illinois has also struggled with urban flooding caused by heavy rains falling on impervious surfaces.⁷⁶

⁷² National Transportation Safety Board, *Derailed of CN Freight Train U70691-18 with Subsequent Hazardous Materials Release and Fire*, <https://www.nts.gov/investigations/AccidentReports/Pages/RAR1201.aspx> (last visited Oct. 11, 2018).

⁷³ CBC.ca, *CN Blamed for Fatal Train Derailment in Illinois*, <https://www.cbc.ca/news/canada/cn-blamed-for-fatal-train-derailment-in-illinois-1.1139430> (last visited Oct. 12, 2018).

⁷⁴ Illinois Attorney General, *Attorney General Madigan Reaches Settlement to Recover Costs of Rockford Train Derailment, Ethanol Leak*, http://www.illinoisattorneygeneral.gov/pressroom/2015_03/20150305.html (last visited Oct. 12, 2018).

⁷⁵ *Crews Find Body of Woman Swept Away by Flood in Galena*, ROCKFORD REGISTER STAR (July 30, 2011), available at www.rrstar.com/x555032097/Crews-find-body-of-woman-swept-away-by-flood-in-Galena

⁷⁶ NOAA National Centers for Environmental Information, *State Climate Summaries: Illinois*, <https://statesummaries.ncics.org/il> (last visited Oct. 11, 2018).

2011 JO DAVIESS COUNTY FLOOD



Images from Rockford Register Star

Furthermore, rising average temperatures injures Illinois residents. Hotter weather will inevitably harm public health and lead to heat-related deaths. For instance, over 700 Illinois residents died due to the historically intense heat wave in July 1995.⁷⁷ Intensified drought conditions strengthen these impacts—the inverse of heavy precipitation.

Though catastrophes such as these have occurred from time to time throughout Illinois' history, climate change will cause them to happen more frequently and with more ferocity than ever before, at the cost of the lives and health of Illinois residents.

Iowa

Climate change increases Iowa's propensity for flooding and droughts, creates challenges for the state's agricultural economy, and poses risks to public health. While already experiencing

⁷⁷ Jan C. Semenza, *et al.*, *Heat Related Deaths During the 1995 Heat Wave in Chicago*, THE NEW ENGLAND JOURNAL OF MEDICINE (July 11, 1996), available at <https://www.nejm.org/doi/full/10.1056/NEJM199607113350203>.

some of climate change's adverse effects, Iowa will likely only become more susceptible to climate change-related harms as average temperatures continue to increase.

Climate change influences the frequency and duration of precipitation events, and Iowa is feeling the effects.⁷⁸ Over the past half century, Iowa has seen an increase in annual precipitation and a greater frequency of extreme rain events.⁷⁹ The latest science suggests that the increase in precipitation will continue, while Iowa will also continue experiencing more significant drought in some areas.⁸⁰ The increased rain events are due to higher surface evaporation from a warmer world, while dry spells are due to reduced evaporation stemming from a lack of moisture.⁸¹ In other words, changes in Iowa's climate will likely continue to make wet seasons wetter and dry seasons dryer.

Extreme rain events have caused significant flooding throughout Iowa, and with Iowa's over 70 interior rivers,⁸² the flooding has adversely affected much of Iowa's population. Since 1990, Iowa has had over 30 presidentially declared flood-related disaster declarations.⁸³ The flooding has caused an estimated 13.5 billion dollars worth of property-related damage.⁸⁴ In 2016, a presidential declaration identified 19 counties affected by severe flooding, many of which were also hit hard by flooding in 2008.⁸⁵ In 2018 alone, 30 counties have already been identified in presidential disaster declarations due to severe storms and flooding.⁸⁶

Heavy rainfall and melting snow have also led to significant flooding in Iowa's bordering Mississippi and Missouri Rivers. In 2011, the high level of the Mississippi River forced navigation closures and caused billions of dollars in damage downstream.⁸⁷ That same year,

⁷⁸ *Iowa Climate Statement 2017*, CTR. FOR GLOBAL & REGIONAL ENVTL. RES., 1 (2017), https://cgrer.uiowa.edu/sites/cgrer.uiowa.edu/files/wysiwyg_uploads/Iowa%20Climate%20Statement%202017_It's%20not%20just%20the%20heat,%20it's%20the%20humidity!_FINAL_August_10_2017.pdf.

⁷⁹ Iman Mallakpour & Gabriele Villarini, *The Changing Nature of Flooding Across the Central United States*, 5 NATURE CLIMATE CHANGE, 250, 250–54 (2015).

⁸⁰ *What Climate Change Means for Iowa*, EPA 1 (Aug. 2016), <https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ia.pdf>.

⁸¹ Chia Chou et al., *Increase in the Range Between Wet and Dry Season Precipitation*, 6 NATURE GEOSCIENCE, 263, 263–67 (2013).

⁸² *Interior Rivers*, IOWA DEP'T OF NAT. RESOURCES, <http://www.iowadnr.gov/Fishing/Where-to-Fish/Interior-Rivers> (last visited Oct. 2, 2018).

⁸³ *Iowa Disaster History*, IOWA HOMELAND SECURITY & EMERGENCY MGMT., https://www.homelandsecurity.iowa.gov/disasters/iowa_disaster_history.html (last visited Oct. 2, 2018).

⁸⁴ *Iowa Flood Center: For Legislators*, U. IOWA, <https://iowafloodcenter.org/resources/for-legislators/> (last visited Oct. 2, 2018).

⁸⁵ *Iowa Disaster History*, IOWA HOMELAND SECURITY & EMERGENCY MGMT., *supra*.

⁸⁶ *Id.*

⁸⁷ HENRY DEHAAN ET AL., USACE, MISS. VALLEY DIV., MISSISSIPPI RIVER AND TRIBUTARIES SYSTEM 2011 POST-FLOOD REPORT V-12 (2012).

flooding along the Missouri River led to hundreds of millions of dollars in damages⁸⁸ and also closed the river to navigation.⁸⁹ Iowa's Sioux City and Council Bluffs were two of the cities affected most by the flood, experiencing extensive property damage and crop loss.⁹⁰

Iowa also has felt the impacts of climate change in its dry seasons. As recently as 2017, drought conditions throughout the state left locations with rainfall at less than 50 percent of normal precipitation.⁹¹ In 2012, a prolonged drought cost the region more than \$250 million when the scarcity of water led to narrowed navigation channels, forced lock closures, and dozens of barges running aground on the Mississippi River.⁹²

Iowa has warmed between one-half to one degree in the last century, and a continued increase in temperature may lead to more challenges for Iowa's agricultural economy.⁹³ Iowa leads the nation in egg production, harvested acreage of principal crops, corn export value, corn for grain production, and hog and pig inventory.⁹⁴ Climate change may put additional heat stress on farmers' crops and livestock, posing a greater risk of substantial decreases in crop yields and livestock productivity.⁹⁵ Under some estimates, absent significant adaptation by Iowa farmers, the state could face declines in its corn crop of 18-77 percent—a significant blow to a corn industry currently worth nearly \$10 billion.⁹⁶ Crop production can be inhibited by changing rain patterns such as wetter springs—which delay planting and increase flood risk—and less rain

⁸⁸ DEP'T OF HOMELAND SEC., MISSOURI RIVER FLOOD COORDINATION TASK FORCE REPORT, 12, 39 (2011).

⁸⁹ David Bailey & David Hendee, *The Mighty Missouri River: The Flooding and the Damage Done*, (Sep. 3, 2011, 8:45 AM), <http://www.reuters.com/article/us-missouri-flooding/the-mighty-missouri-river-the-flooding-and-the-damage-done-idUSTRE78213720110903>.

⁹⁰ DEP'T OF HOMELAND SEC., MISSOURI RIVER FLOOD COORDINATION TASK FORCE REPORT, *supra*, at 39.

⁹¹ Craig Cogil, *Extreme Drought Expands in Southern Iowa*, NAT'L WEATHER SERV. 1 (Sep. 18, 2017), <https://www.weather.gov/media/dmx/Climate/Drought.pdf>.

⁹² U.S. ARMY CORPS OF ENG'RS, EVENT STUDY: 2012 LOW-WATER AND MISSISSIPPI RIVER LOCK 27 CLOSURES, 6–7, 37 (2013), http://www.lrd.usace.army.mil/Portals/73/docs/Navigation/PCXIN/Drought_2012_Report_-_FINAL_2013-08-30.pdf; See Harry J. Hillaker, *The Drought of 2012 in Iowa*, IOWA DEP'T OF AGRIC. AND LAND STEWARDSHIP, <http://www.iowaagriculture.gov/climatology/weatherSummaries/2012/DroughtIowa2012Revised.pdf> (last visited Oct. 2, 2018).

⁹³ *What Climate Change Means for Iowa*, *supra*, at 1.

⁹⁴ *Iowa's Rank in United States Agriculture*, USDA (May 2018), https://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/Rankings/IA-2018-Rankings.pdf.

⁹⁵ *What Climate Change Means for Iowa*, *supra*, at 2.; J. L. Hatfield et al., *Vulnerability of Grain Crops and Croplands in the Midwest to Climatic Variability and Adaptation Strategies*, 146 CLIMATIC CHANGE, 263, 263–64 (2018).

⁹⁶ Kate Gordon et al., *Heat in the Heartland: Climate Change and Economic Risk in the Midwest*, RISKY BUSINESS 33 (2015); <http://riskybusiness.org/site/assets/uploads/2015/09/RBP-Midwest-Report-WEB-1-26-15.pdf>

during the increasingly hot summers.⁹⁷ Farmers may also face the survival and spread of more unwanted pests because of warmer winters and a longer growing season.⁹⁸

Climate change also puts Iowans' public health at risk. The higher temperatures can increase air pollutants such as ozone and fine particulates, which increase the risk of heart and lung-related illness.⁹⁹ Allergic diseases and asthma are expected to become more widespread and more severe due to exposure to new plants and increases in pollen counts.¹⁰⁰ The warmer, wetter climate can even increase the risk of infectious diseases transmitted by insects that will be better able to live in a more humid and warm Iowa environment.¹⁰¹ Iowans' health risks will only likely increase as average temperatures continue to increase.

Maine

Maine is experiencing significant, negative effects of climate change through rising sea levels, ocean acidification, and invasive species that are expanding their range northward as the environment warms. By way of example, the Gulf of Maine is warming faster than 99% of the world's ocean waters.¹⁰² These warmer waters have brought with them an invasion of non-native green crabs that are devastating soft-shell clam flats throughout southern and mid-coast Maine, and threaten Maine's \$1.7 billion lobster industry.¹⁰³ At the same time, ocean waters globally have become approximately 30% more acidic over the last century, and features of the Gulf of Maine, including its extensive freshwater inputs, make it particularly vulnerable to acidification.¹⁰⁴ These symptoms of climate change threaten both the health of the State's marine ecosystem and a coastal economy that depends on it.

⁹⁷ *What Climate Change Means for Iowa*, *supra*, at 1.

⁹⁸ Sara C. Pryor et al., *Midwest*, in CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 418, 435 (J. M. Melillo et al. eds., 2014).

⁹⁹ *What Climate Change Means for Iowa*, *supra*, at 2.

¹⁰⁰ *Climate Change*, IOWA DEP'T OF NAT. RESOURCES, <http://www.iowadnr.gov/Conservation/Climate-Change> (last visited Oct. 2, 2018).

¹⁰¹ *Id.*

¹⁰² Woodard, C., *Mayday: Gulf of Maine in Distress*, Portland Press Herald, October 25, 2015, <http://www.pressherald.com/2015/10/25/climate-change-imperils-gulf-maine-people-plants-species-rely/>

¹⁰³ *Id.*; Dahlman, L, *Climate Change, Ocean Heat Content*, National Oceanic and Atmospheric Administration, <https://www.climate.gov/news-features/climate-and/climate-lobsters>; Hall, J., *From Bought to Caught, Lobsters all about Economics*, Portland Press Herald, August 11, 2012, http://www.pressherald.com/2012/08/11/market-forces-make-everyone-feel-the-pinch_2012-08-12/

¹⁰⁴ Gledhill, D.K., et al., *Ocean and Coastal Acidification off New England and Nova Scotia*, *Oceanography* 28(2):182–197, 2015, <http://dx.doi.org/10.5670/oceanog.2015.41>. <https://climate.nasa.gov/evidence/>; <http://tos.org/oceanography/article/ocean-and-coastal-acidification-off-newengland-and-nova-scotia>.

Similar changes are occurring in Maine's interior. Iconic species that drive the State's tourist economy are suffering from the effects of global warming. Longer, hotter summers and more frequent droughts are shrinking brook trout habitat¹⁰⁵ and undermining efforts to restore sea-run salmon in Maine's downeast rivers.¹⁰⁶ A plague of winter ticks brought on by decreased snowpack has taken a significant toll on Maine's moose population.¹⁰⁷ Milder winters have also hurt the ski industry,¹⁰⁸ while shorter and earlier springs are interfering with maple sugaring operations.¹⁰⁹

Maryland

With more than 3,000 miles of coastline, Maryland's coast is particularly vulnerable to rising sea levels and the more extreme weather events associated with climate change: shoreline erosion, coastal flooding, storm surges, inundation, and saltwater intrusion into groundwater supplies.

In 2007, the Maryland Commission on Climate Change (MCCC) was established by Executive Order 01.01.2007.07 and was charged with evaluating and recommending state goals to reduce Maryland's greenhouse gas emissions to 1990 levels by 2020 and to reduce those emissions to 80 percent of their 2006 levels by 2050. The MCCC was also tasked with developing a plan of action that addressed the causes and impacts of climate change and included firm benchmarks and timetables for policy implementation. As a result of the work of more than 100 stakeholders and subject matter experts, the MCCC produced a climate action plan. That plan was the impetus for Maryland's Greenhouse Gas Emissions Reduction Act of 2009, an enhanced version of which became law in 2016.¹¹⁰

¹⁰⁵ Pennsylvania State University, *For Trout Fishermen, Climate Change Will Mean More Driving Time, Less Angling*, ScienceDaily, August 20, 2015, www.sciencedaily.com/releases/2015/08/150820123648.htm.

¹⁰⁶ The National Academies Press, *Atlantic Salmon in Maine*, 2004, at 50-53, <https://www.nap.edu/read/10892/chapter/5>.

¹⁰⁷ Fleming, D., *Winter Ticks Raise Concerns about the Future of Maine's Moose Herd*, Portland Press Herald, June 14, 2014, <http://www.pressherald.com/2014/06/14/winter-ticks-raise-concerns-about-future-of-maines-moose-herd/>.

¹⁰⁸ Seelye, K., *Rising Temperatures Threaten Fundamental Change for Ski Slopes*, The New York Times, December 12, 2012, <http://www.nytimes.com/2012/12/13/us/climate-change-threatens-ski-industrys-livelihood.html>.

¹⁰⁹ Taylor, C., *How Climate Change Threatens Your Breakfast*, Science Friday, March 17, 2017, <https://www.sciencefriday.com/segments/how-climate-change-threatens-your-breakfast/>.

¹¹⁰ Maryland Commission on Climate Change, 2016 Annual Report 7, http://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MCCC_2016_final.pdf ("MCCC 2016 Annual Report").

As emphasized by the MCCC’s Science and Technical Working Group, estimates show that “Maryland is projected to experience between 2.1 and 5.7 feet of sea level rise over the next century. In fact, sea level could be as much as 2.1 feet higher in 2050 along Maryland’s shorelines than it was in 2000.”¹¹¹

Sea level rise could inundate some facilities of the Port of Baltimore, placing one of the most important ports along the East Coast at risk. In 2016, for instance, the Port generated nearly \$3 billion in wages and salaries, supported over 13,000 direct jobs, and moved 31.8 million tons of international cargo.¹¹²

The state’s tourism sector is also likely to feel the impact of climate change.¹¹³ In 2015, for instance, tourism resulted in \$2.3 billion in tax revenue, which directly supported more than 140,000 jobs with a payroll of \$5.7 billion.¹¹⁴ Rising sea levels, flooding, and heightened storm surges will place further strain on Maryland’s low-lying urban and coastal lands, making tourism less feasible and increasing the costs of maintaining bridges, roads, boardwalks, and other tourism infrastructure.¹¹⁵ Beaches, moreover, “will move inland at a rate 50 to 100 times faster than the rate of sea level elevation” and “the cost of replenishing the coastline after a 20-inch rise in sea level would be between \$35 million and \$200 million.”¹¹⁶

Further, skiing and other snow sports “are at obvious risk from rising temperatures, with lower-elevation resorts facing progressively less reliable snowfalls and shorter seasons.”¹¹⁷ Wisp Mountain Park, for example, is a popular skiing destination in Western Maryland, and the only ski resort in the State. Even in late December of 2015, only one of the resort’s 35 trails was open because of the difficulty keeping snow on the ground in above-freezing temperatures.¹¹⁸

Climate change may also adversely impact Maryland’s agricultural industry, which employs some 350,000 people.¹¹⁹ In 2015, the market value of agricultural products produced in

¹¹¹ Maryland Commission on Climate Change, 2015 Annual Report 13, <http://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Publications/MCCC2015Report.pdf> (“MCCC 2015 Annual Report”).

¹¹² Maryland Commission on Climate Change, 2017 Annual Report 12, http://www.mde.state.md.us/programs/Air/ClimateChange/MCCC/Documents/MCCC_2017_final.pdf (“MCCC 2017 Annual Report”).

¹¹³ Center for Climate and Energy Solutions, Cost of Inaction Supplement, September 2015, <https://www.c2es.org/document/climate-change-the-cost-of-inaction-for-marylands-economy/>.

¹¹⁴ Maryland Office of Tourism Development, Fiscal Year 2016 Tourism Development Annual Report, 2016, available at: <http://industry.visitmaryland.org/research/annual-reports/annual-reports-archive/>.

¹¹⁵ MCCC 2015 Annual Report 14, *supra*.

¹¹⁶ MCCC 2017 Annual Report 16, *supra*.

¹¹⁷ MCCC 2016 Annual Report 18-19, *supra*.

¹¹⁸ MCCC 2017 Annual Report 15, *supra*.

¹¹⁹ *Id.* at 13.

Maryland was \$2.2 billion, with net farm income exceeding \$500 million.¹²⁰ By 2050, absent additional action, rising summer temperatures could result in nearly \$150 million in median annual losses for corn, soy, and wheat.¹²¹ Increased flooding could adversely affect the stability, salinity, drainage, and nutrient balance of soil in low-lying areas, causing declines in crop production and making farming less viable. Rising seas could lead salt water to flow into aquifers used for irrigation. Livestock could suffer from higher temperatures, too, and would need more access to cooler areas. By causing soil erosion and nutrient runoff, moreover, increased rainfall could adversely affect water quality, including in the Chesapeake Bay.¹²²

Climate change will have significant effects on forests, which contribute some \$2.2 billion to the Maryland economy, as well as \$24 billion in ecological services.¹²³ Climate change will exacerbate species' existing stressors and alter their distribution, with some species likely to leave or decline and others likely to arrive or increase. Further, the services that forests provide—such as temperature regulation and water filtration—may be affected by climate change.¹²⁴

Climate change also threatens the Chesapeake Bay, the largest estuary in the United States. Development and pollution have made the Bay and its ecosystems more vulnerable to stressors, including those resulting from climate change. Already, the Bay has warmed by three degrees Fahrenheit. Further temperature increases could change the composition of commercial fisheries and deprive aquatic life of the oxygen needed to survive. Some species are likely to move north towards cooler waters and more suitable habitats. Other forms of aquatic life, including invasive pests and diseases, are likely to arrive or proliferate in the Bay's newly-warmed waters.¹²⁵

In terms of health impacts, Maryland is likely to experience increasing numbers of 90-degree days, markedly exacerbating heat-related illnesses and mortality, particularly among the elderly.¹²⁶ A two-week heat wave in 2012, for instance, led to 12 deaths in Maryland.¹²⁷ By mid-century, rising temperatures could cause 27 additional deaths each summer in Baltimore alone.¹²⁸

¹²⁰ *Id.* at 14.

¹²¹ MCCC 2015 Annual Report 15, *supra*.

¹²² *Id.*

¹²³ *Id.*

¹²⁴ *Id.* at 15-16.

¹²⁵ *Id.* at 16.

¹²⁶ MCCC 2017 Annual Report 9, 17, *supra*.

¹²⁷ MCCC 2016 Annual Report 18-19, *supra*.

¹²⁸ *Id.*

Massachusetts

Temperatures in Massachusetts have warmed by an average of 1.3 degrees Celsius since 1895, almost twice as much as the rest of the contiguous 48 states. According to recent research by the University of Massachusetts, the Northeast, including Massachusetts, will continue to see temperatures rise higher more quickly than the rest of the United States and the world.¹²⁹

Rising temperatures will result in milder winters with more freeze-thaw cycles and less precipitation falling as snow and instead as rain and freezing rain. Hotter summers will increase the number, intensity, and duration of heat waves and lead to poorer air quality.¹³⁰ Massachusetts already has the nation's highest incidence of pediatric asthma: among Massachusetts children in kindergarten to eighth grade, more than 12 percent suffer from pediatric asthma, and 12 percent of Massachusetts's adult population suffers from asthma.¹³¹ Warmer temperatures increase ground level ozone, which impairs lung function and can result in increased hospital admissions and emergency room visits for people suffering from asthma, particularly children. Higher temperatures and carbon dioxide levels also will cause plants to produce more pollen, which can exacerbate asthma and other respiratory illnesses. More extreme heat also presents health hazards for people, including increased cardiovascular disease, Type II diabetes, renal disease, nervous disorders, emphysema, epilepsy, cerebrovascular disease, pulmonary conditions, mental health conditions, and death—especially for our most vulnerable residents.

The Northeast has seen the country's largest increases in heavy precipitation events (more than a 70-percent increase in the heaviest 1 percent of all events since 1958).¹³² Some areas in Massachusetts have shown an increasing trend in the number of days with two inches of precipitation or more from 1970-2008. For example, over the last 60 years, the Connecticut River basin has experienced more than a doubling of heavy rainfall events. Regionally, the majority of heavy precipitation events have occurred during the summer months of May through September.¹³³ One hundred-year flood events are now occurring every 60 years, and 50-year floods are now occurring approximately every 30 years. Flooding has increased in association with extreme precipitation events, causing costly property damage and putting fish, wildlife, and their habitats at increased risk. Since 1990, Massachusetts has been affected by numerous major

¹²⁹ Horton et al., *Northeast*, in CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT, 373 (2014), at <http://nca2014.globalchange.gov/report/regions/northeast>; see also EPA, Fact Sheet: What Climate Change Means for Massachusetts (Aug. 2016), at <https://ia801602.us.archive.org/9/items/climate-change-ma/climate-change-ma.pdf>.

¹³⁰ Massachusetts Department of Public Health, *Capacity to Address the Health Impacts of Climate Change in Massachusetts*, 6 (April 2014), at <http://www.mass.gov/eohhs/docs/dph/environmental/exposure/climate-change-report-2014.pdf>.

¹³¹ *Id.*; Centers for Disease Control and Prevention, 2014 Adult Asthma Data: Prevalence Tables and Maps, at <https://www.cdc.gov/asthma/brfss/2014/tableC1.htm>; Massachusetts Department of Public Health, Pediatric Asthma, at <https://matracking.ehs.state.ma.us/Health-Data/Asthma/pediatric.html>.

¹³² Horton, *supra*, at 373.

¹³³ Massachusetts Climate Action Partnership, *Massachusetts Wildlife Climate Action Tool – Stressors: Storms and floods* (2015), at <https://climateactiontool.org/content/storms-and-floods>.

weather disasters, including Superstorm Sandy and Tropical Storm Irene.¹³⁴ Superstorm Sandy, a post-tropical storm in 2012, was the most extreme and destructive event to affect the northeastern United States in 40 years and the second costliest in the Nation's history. Storm impacts in Massachusetts included strong winds, record storm tide heights, flooding of some coastal areas and loss of power for 385,000 residents.¹³⁵ Massachusetts suffered an estimated \$375 million in property losses alone.¹³⁶ In January 2018, the storm surge from a powerful winter storm caused major coastal flooding and resulted in a high tide in Boston of 15.16 feet, the highest tide since records began in 1921, even surpassing the infamous Blizzard of 1978.¹³⁷ And two months later, a March coastal storm resulted in a 14.67 foot Boston tide (the third-highest on record¹³⁸), damaged 2,113 homes, including 147 that were destroyed, and caused more than \$24 million in flooding damage across six Massachusetts coastal counties.¹³⁹

Beyond the damage that more intense storms can cause homes, businesses, and private and public infrastructure generally, such events also threaten the aging combined sewer and stormwater systems serving many Massachusetts cities such as Boston and Lowell. Heavy precipitation and coastal flooding can overwhelm these systems and release untreated sewage to our rivers and coastal waters, threatening public health and water quality.¹⁴⁰

Massachusetts is a coastal state especially vulnerable to sea level rise caused by climate change, which is already exacerbating coastal flooding and erosion from storm events and will eventually inundate low-lying communities, including the City of Boston. Roughly 5 million Massachusetts residents—75% of the state's population—live near the coast.¹⁴¹ The total output of the Massachusetts coastal economy was \$249.2 billion in 2014, representing over 54% of the state's annual gross domestic product, and coastal counties accounted for 53% of the state's

¹³⁴ Runkle et al., *Massachusetts State Summary*, NOAA TECHNICAL REPORT NESDIS 149-MA, 4 (2017), at <https://statesummaries.ncics.org/MA>.

¹³⁵ *Id.*

¹³⁶ *Id.*

¹³⁷ Martin Finucane, *It's official: Boston breaks tide record*, BOSTON GLOBE, Jan. 5, 2017, at <https://www.bostonglobe.com/metro/2018/01/05/official-boston-breaks-tide-record/UPbwDxgF0QXNOWvB9bcQ7L/story.html>.

¹³⁸ Christina Prignano, *The Noon High Tide Was Bad, but the Midnight High Tide Could Be Worse*, BOSTON GLOBE, March 2, 2018, at <https://www.bostonglobe.com/metro/2018/03/02/the-noon-high-tide-was-bad-but-midnight-high-tide-will-worse/m4O1PR8HRioLsmx3mp2YvO/story.html>.

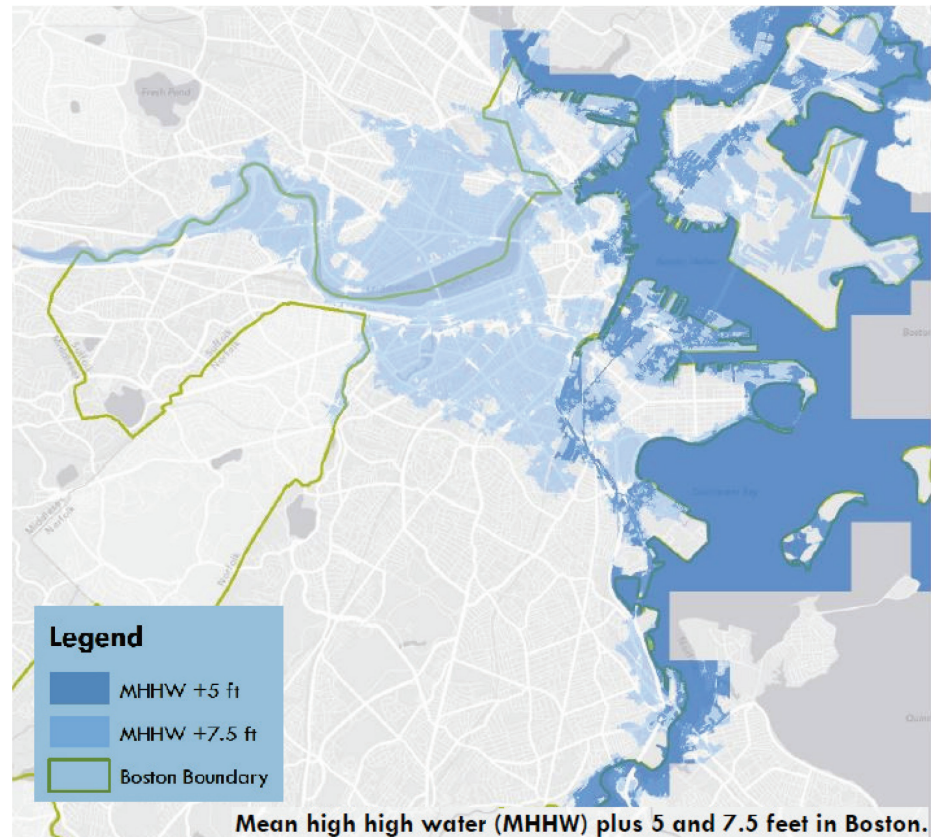
¹³⁹ Christian M. Wade, *Baker Seeks Federal Disaster Funds for Storm Damages*, LAWRENCE EAGLE-TRIBUNE, May 1, 2018, at https://www.eagletribune.com/news/merrimack_valley/baker-seeks-federal-disaster-funds-for-storm-damages/article_d2f0c7b4-bd75-5a8b-8a0c-4dedbe44a7b4.html.

¹⁴⁰ City of Boston, *Climate Ready Boston, Final Report*, 290 (December 2016), at https://www.boston.gov/sites/default/files/20161207_climate_ready_boston_digital2.pdf.

¹⁴¹ NOAA, National Coastal Population Report, 9 (2013), at <https://aamboceanservice.blob.core.windows.net/oceanservice-prod/facts/coastal-population-report.pdf>.

employment and wages.¹⁴² According to the National Climate Assessment, in Boston alone, cumulative damage to buildings, building contents, and associated emergency costs could potentially be as high as \$94 billion between 2000 and 2100, depending on the sea level rise scenario and which adaptive actions are taken.¹⁴³

Increased sea level, combined with increased erosion rates, is also predicted to threaten Massachusetts' barrier beach and dune systems. Development on the beaches themselves, as in the case of Plum Island, will continue to face challenges associated with erosion and storm damage. Barrier beaches will be more susceptible to erosion and overwash, and in some cases breaching. Such breaching will put at risk extensive areas of developed shoreline located



behind these barrier spits and islands, such as the shorelines of Plymouth, Duxbury, and Kingston. Engineered structures, such as seawalls designed to stabilize shorelines, could be overtopped. The cost of maintaining and upgrading these engineering structures and replenishing dunes and beaches damaged by erosion will increase as sea levels rise, requiring investments of millions of dollars by local governments.¹⁴⁴ Large areas of critical coastal and estuarine habitat, including the North Shore's Great Marsh—the largest continuous stretch of salt marsh in New

¹⁴² NAT'L OCEAN ECONOMICS PROGRAM, STATE OF THE U.S. OCEAN AND COASTAL ECONOMIES: COASTAL STATES SUMMARIES – 2016 UPDATE 29 (2016), at http://midatlanticocean.org/wp-content/uploads/2016/03/CoastalStatesSummaryReports_2016.pdf

¹⁴³ Horton, *supra*, at 379.

¹⁴⁴ For one example, a recent, large-scale beach replenishment project in Winthrop, Massachusetts secured \$26 million in state funds for completion. See Beth Daley, *Sand Wars Come to New England*, BOSTON GLOBE, (Dec. 15, 2013), available at <https://www.bostonglobe.com/lifestyle/health-wellness/2013/12/15/sand-wars-come-new-england-coast/F2CIK6e20wtcZeCoUQC9AM/story.html>.

England, extending from Cape Ann to New Hampshire—are at risk as they will be unable to adapt and migrate as sea level rises and local land subsides.¹⁴⁵

Massachusetts already is seeing what climate change means for our natural resources. The signs of spring—including the arrival of migratory birds and the blooming of wildflowers and other plants—are arriving earlier. Warmer temperatures also are contributing to the rise in deer populations in Massachusetts, resulting in loss of underbrush habitat for forest species and the spread of tick-borne diseases such as Lyme disease. As the Gulf of Maine is warming much faster than other water bodies, key cold-water ocean fisheries, including cod and lobster, are in decline. The timing of the migration of anadromous fish species, such as Atlantic salmon and alewives, has advanced in the last few decades, and they are migrating earlier in the season.¹⁴⁶

Minnesota

Minnesota's climate is changing, and it's already affecting residents' health and the state's environment and economy. Rising temperatures may interfere with winter recreation, extend the growing season, change the composition of trees in the North Woods, and increase water pollution problems in lakes and rivers. The state will have more extremely hot days, which may harm public health in urban areas and corn harvests in rural areas.

The Minnesota Pollution Control Agency (MPCA) is a member of Minnesota's Environmental Quality Board (EQB). EQB's 2015 "Minnesota and Climate Change: Our Tomorrow Starts Today" report, outlines many changes our state is already experiencing as a result of climate change.¹⁴⁷ Minnesota is getting warmer and increases in temperatures means ice cover on lakes is forming later and melting sooner, which impacts traditional winter sports and tourism; the ragweed pollen season is increasing; and Minnesota is seeing a rise in tick- and mosquito-borne illnesses; among other current and expected impacts.

Minnesota has gotten noticeably warmer, especially over the last few decades. The temperature in the state has increased 1°F to 2°F since the 1980s.¹⁴⁸ Since the beginning of

¹⁴⁵ City of Boston, *Climate Ready Boston*, *supra*, at 60.

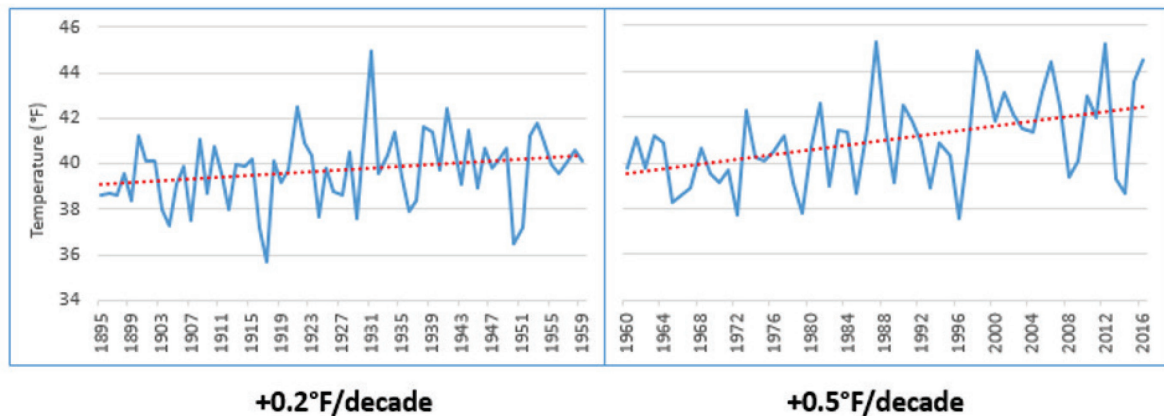
¹⁴⁶ EPA, Fact Sheet: What Climate Change Means for Massachusetts, *supra*; Massachusetts Climate Action Partnership, *supra* note 99, *Ecology and Vulnerability: Alewife*, at <http://climateactiontool.org/species/alewife>.

¹⁴⁷ Environmental Quality Board, "Minnesota and Climate Change: Our Tomorrow Starts Today" (2015), available at <https://www.eqb.state.mn.us/content/climate-change>

¹⁴⁸ *Minnesota and Climate Change: Our Tomorrow Starts Today*, at 6, available at: (<https://www.eqb.state.mn.us/content/climate-change>) (hereinafter "Minnesota and Climate Change,") citing *Climate at a Glance: Time Series* (n.d.) (retrieved July 2014, from National Climatic Data Center, available at: <http://www.ncdc.noaa.gov/cag/time-series>) and Zandlo, J. (2008, March 13), *Climate Change and the Minnesota State Climatology Office: Observing the Climate* (retrieved July 2, 2014, from Minnesota Climatology Working Group, available at <http://climate.umn.edu/climateChange/climateChangeObservedNu.htm>); see also Pryor, S. C. et al., 2014: Ch. 18: Midwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*,

the data record (1895) through 1959, Minnesota's annual average temperature increased by nearly 0.2°F per decade, which is equivalent to over 2°F per century. This is shown in the graph at the left (below). This warming effect has accelerated over the last 50 plus years. Data from 1960-2016 show that the recent rate of warming for Minnesota has sped up substantially to over 0.5°F per decade, which is equivalent to 5.0°F per century. This is shown in the graph to the right (below).

Minnesota Average Annual Temperature, 1895 -2016



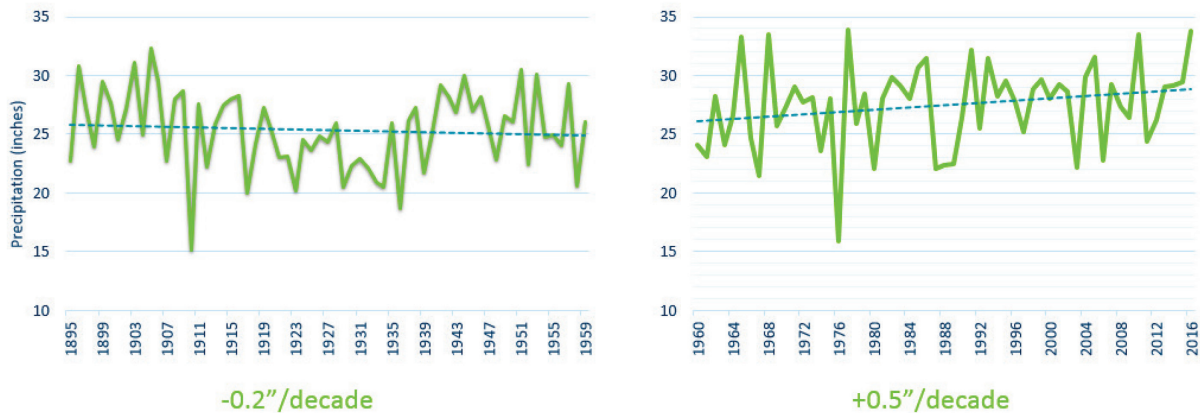
Source: NOAA, 2017

With a warming atmosphere, more evaporation occurs. The graph on the left (below) highlights the trend for the early part of the last century, 1895-1959, while the graph on the right (below) highlights the trend for the most recent half century, 1960-2016. For most of the first half of the 20th century, the trend in precipitation was slightly downward, at a loss of 0.2 inches per decade or the equivalent of -2 inches per century. This downward trend was influenced by the Dust Bowl years of the 1930s. However, the rate of precipitation across the state has increased by nearly 0.5 inches per decade or the equivalent of 5 inches per century over the last 50+ years.¹⁴⁹

J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440. doi:10.7930/J0J1012N.

¹⁴⁹ See Minnesota Dep't of Health, *Climate Change in Minnesota*, www.health.state.mn.us/divs/climatechange/climate101.html (last visited Oct. 24, 2018) (relying on NOAA data)

Minnesota Average Annual Precipitation, 1895-2016



Source: NOAA, 2017

Floods are becoming more frequent. According to EPA, over the last half century, average annual precipitation in most of the Midwest has increased by 5 to 10 percent, with greater inter-annual variability.¹⁵⁰ But rainfall during the four wettest days of the year has increased about 35 percent.¹⁵¹ Yearly frequency of the largest storms – those with three inches or more of rainfall in a single day – have more than doubled in just over 50 years.¹⁵² In the past decade, such dramatic rains have increased by more than 70 percent. Since 2004, Minnesota has experienced three 1,000-year floods and an increase in intense weather events including hailstorms, tornadoes and droughts. In 2007, we saw several counties in the state receive drought designation, while others were declared flood disasters – an occurrence that repeated itself in 2012 when 11 counties declared flood emergencies while 55 received drought designations.

Climate change impacts outside of Minnesota have affected our air quality and our health. Since 2015, thirteen of seventeen air quality alerts issued by the Minnesota Pollution Control Agency are directly attributable to wildfires or forest fires in Canada or the western United States.

Climate change has caused financial impacts to Minnesota as well. In 2013, Minnesota had some of the highest weather-related disaster claims in the nation. Since 1997, 32 severe weather natural disasters have cost Minnesota nearly \$500 million in natural disaster recovery

¹⁵⁰ U.S. EPA, *What Climate Change Means for Minnesota* (August 2016), available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwibxob4l4zXAhXs6YMKHcl0BnUQFggoMAA&url=https%3A%2F%2Fwww.epa.gov%2Fsites%2Fproduction%2Ffiles%2F2016-09%2Fdocuments%2Fclimate-change-mn.pdf&usg=AOvVaw13tl9K6gVwguua3_nhSUzk

¹⁵¹ *Id.*

¹⁵² Minnesota and Climate Change, *supra*, at 6; see also Saunders, S. et al., *Doubled Trouble: More Midwestern Extreme Storms*. Rocky Mountain Climate Organization; Natural Resources Defense Council (2012).

assistance to affected jurisdictions alone.¹⁵³ The impacts of climate change are expected to worsen in Minnesota, affecting our economy, our ecosystems and the health of all Minnesotans.

New Mexico

The Southwest and New Mexico are experiencing the effects of climate change at a rate much faster than the majority of U.S. states. Warming trends in the southwestern U.S. have exceeded global averages by nearly 50 percent since the 1970s, and average temperatures in New Mexico have been increasing 50 percent faster than the global average over the past century.¹⁵⁴ Temperatures in the Upper Rio Grande River basin are increasing at a rate of roughly 0.7° F per decade, contributing to an average warming of 2.7° F since 1970.¹⁵⁵ Mountains have shown a higher rate of temperature rise when compared to lower elevations.¹⁵⁶ Both minimum and maximum monthly temperatures also show rising trends. The number of very hot days and nights -- defined as temperatures above the warmest 10 percent of days on record -- has increased since 1950. Heat waves lasting longer than four days have also significantly increased since 1960.¹⁵⁷ These occurrences do not only affect a specific part of the state; over 95 percent of New Mexico has experienced mean temperature increases.¹⁵⁸

Key findings from the Third U.S. National Climate Assessment (Assessment) for the Southwest include:

- Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.¹⁵⁹ (This is a critical issue for New Mexico because the state's social, economic and environmental

¹⁵³ Minnesota and Climate Change, *supra*, at 6; see also Office of the Legislative Auditor, State of Minnesota (2012), *Helping Communities Recover from Natural Disasters: Evaluation Report Summary*

¹⁵⁴ Nature Conservancy, *Implications of Recent Climate Change*, at iii; Robert Repetto, *New Mexico's Rising Economic Risks from Climate Change*, DEMOS, at 1 (2012).

¹⁵⁵ Jason Funk et al., *Confronting Climate Change in New Mexico* at 6-7, 9 (Union of Concerned Scientists, April 2016); www.ucsusa.org/NewMexicoClimateChange (last visited Oct. 18, 2018).

¹⁵⁶ Dagmar Llewellyn & Seshu Vaddey, *West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment*, at 1, 37-38, 117 (U.S. Department of Interior, Bureau of Reclamation, Dec. 2013); [https://www.usbr.gov/watersmart/baseline/docs/urgia/URGIAMainReport.pdf](https://www.usbr.gov/watersmart/baseline/docs/urguia/URGIAMainReport.pdf) (last visited Oct. 19, 2018).

¹⁵⁷ Repetto, Robert, *New Mexico's Rising Economic Risks from Climate Change*, at 1, available at <https://www.demos.org/sites/default/files/publications/UpdatedNMFullReport.pdf> (last visited Oct. 24, 2018); see also Nature Conservancy, *Implications of Recent Climate Change*, *supra*, at 4.

¹⁵⁸ Nature Conservancy, *Implications of Recent Climate Change*, *supra*, at iii.

¹⁵⁹ U.S. Global Change Research Program, *2014 National Climate Assessment*, at 463 (2014), available at <https://nca2014.globalchange.gov/report/regions/southwest%0D> (last visited Jan. 8, 2018).

systems are already water-scarce and thus vulnerable to the supply disruptions which are likely to accompany future climate changes.¹⁶⁰).

- Increased warming, drought, and insect outbreaks caused by or linked to climate change have increased the frequency of catastrophic wildfires impacting people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.¹⁶¹
- The Southwest's 182 federally recognized tribes and communities share particularly high vulnerabilities to climate changes such as high temperatures, drought, forest fires, and severe storms. Tribes may face loss of traditional foods, medicines, and water supplies due to declining snowpack, increasing temperatures, increasing drought, forest fires, and subsequent flooding. Historic land settlements and high rates of poverty – more than double that of the general United States population – constrain tribes' abilities to respond effectively to climate challenges.¹⁶²
- The Southwest produces more than half of the nation's high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increasing temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.¹⁶³
- Increased frost-free season length, especially in already hot and moisture-stressed regions like the Southwest, is projected to lead to further heat stress on plants and increased water demands for crops. Higher temperatures and more frost-free days during winter can lead to early bud burst or bloom of some perennial plants, resulting in frost damage when cold conditions occur in late spring; in addition, with higher winter temperatures, some agricultural pests can persist year-round, and new pests and diseases may become established.¹⁶⁴

Key findings from the Assessment for New Mexico include:

- Streamflow totals in the Rio Grande and other rivers in the Southwest were 5 percent to 37 percent lower between 2001 and 2010 than average flows during the 20th century.

¹⁶⁰ Brian H. Hurd & Julie Coonrod, *Climate Change and Its Implications for New Mexico's Water Resources and Economic Opportunities*, NM State University, Technical Report 45, at 1, 24 (2008); <https://aces.nmsu.edu/pubs/research/economics/TR45.pdf> (last visited Oct. 18, 2018).

¹⁶¹ *Id.*

¹⁶² The White House, Office of the Press Secretary, *FACT SHEET: What Climate Change Means for New Mexico and the Southwest*, at 3 (2014), available at https://obamawhitehouse.archives.gov/sites/default/files/docs/state-reports/NEWMEXICO_NCA_2014.pdf (last visited Oct. 18, 2018); see also *Confronting Climate Change in New Mexico*, *supra*, at 6-7, 9.

¹⁶³ U.S. Global Change Research Program, *2014 National Climate Assessment*, *supra*, at 463.

¹⁶⁴ *Id.*

Projections of further reduction of late-winter and spring snowpack and subsequent reductions in runoff and soil moisture pose increased risks to water supplies needed to maintain cities, agriculture, and ecosystems.¹⁶⁵

- Drought and increased temperatures due to climate change have caused extensive tree death across the Southwest. Winter warming due to climate change has exacerbated bark beetle outbreaks by allowing more beetles, which normally die in cold weather, to survive and reproduce.¹⁶⁶ Wildfire and bark beetles killed trees across one fifth of New Mexico and Arizona forests from 1984 to 2008.¹⁶⁷ Climate changes caused extensive piñon pine mortality in New Mexico between 1989 and 2003.¹⁶⁸
- Exposure to excessive heat can aggravate existing human health conditions, such as respiratory and heart disease. Increased temperatures can reduce air quality because atmospheric chemical reactions proceed faster in warmer conditions. As a result, heat waves are often accompanied by increased ground level ozone, which can cause respiratory distress. Increased temperatures and longer warm seasons will lead to shifts in the distribution of disease-transmitting mosquitoes.¹⁶⁹

Additionally, a recent study led by Los Alamos National Laboratories found that greenhouse gas-driven warming may lead to the death of 72 percent of the Southwest's evergreen forests by 2050, and nearly 100 percent mortality of these forests by 2100.¹⁷⁰

If action is not taken to reduce greenhouse gas emissions, climate models project substantial changes in New Mexico's climate over the next 50 to 100 years. Barring reduction efforts, projected climate changes by mid- to late 21st century include: air temperatures warming by 6-12 degrees Fahrenheit on average, but more so in winter, at night, and at high elevations; more episodes of extreme heat, fewer episodes of extreme cold; more intense storm events and flash floods; and winter precipitation falling more often as rain and less often as snow.¹⁷¹ Severe and sustained drought will stress water sources, already over-utilized in many areas, forcing

¹⁶⁵ *Id.*

¹⁶⁶ *Id.*

¹⁶⁷ *Id.* at 468.

¹⁶⁸ *Id.* at 484.

¹⁶⁹ *What Climate Change Means for New Mexico and the Southwest, supra*, at 2-3.

¹⁷⁰ Chris Mooney, *Scientists say climate change could cause a 'massive' tree die-off in the U.S. Southwest*, WASH. POST, Dec. 21, 2015, available at <https://www.washingtonpost.com/news/energy-environment/wp/2015/12/21/scientists-say-climate-change-could-cause-a-massive-tree-die-off-in-the-southwest/> (last visited March 14, 2019); McDowell, N.G., et al., "Multi-scale predictions of massive conifer mortality due to chronic temperature rise," in *Nature Climate Change* 6, 295-300 (Dec. 2015), <https://doi.org/10.1038/NCLIMATE2873>.

¹⁷¹ *Confronting Climate Change in New Mexico, supra*, at 3.

increasing water-allocation competition among farmers, energy producers, urban dwellers, and ecosystems.¹⁷²

New York

New York has begun to experience adverse effects from climate change. In 2014, the New York Attorney General's Office released a report, *Current and Future Trends in Extreme Rainfall Across New York State*, which highlights dramatic increases in the frequency and intensity of extreme rain storms across New York.¹⁷³ As but one example, devastating rainfall from Hurricane Irene in 2011 dropped more than 11 inches of rain in just 24 hours, causing catastrophic flooding in the Hudson Valley, eastern Adirondacks, Catskills and Champlain Valley. Thirty-one counties were declared disaster areas. Over 1 million people were left without power, more than 33,000 had to seek disaster assistance, and 10 were killed. Damage estimates totaled \$1.3 billion. While no individual storm can be tied to climate change, the trends in extreme rainfall already being felt across New York State are consistent with scientists' predictions of new weather patterns attributable to climate change.

Hurricane Irene Flooding



Image from ABC 7 Eyewitness News

¹⁷² *What Climate Change Means for New Mexico and the Southwest, supra*, at 1-2.

¹⁷³ *Current & Future Trends in Extreme Rainfall Across New York State, A Report from the Environmental Protection Bureau of the New York State Attorney General* (Sept. 2014) (based on data from the 2014 National Climate Assessment and the National Oceanographic and Atmospheric Administration's Northeast Regional Climate Center), available at: https://ag.ny.gov/pdfs/Extreme_Precipitation_Report%209%202%2014.pdf

Similarly, in August 2014, a weather front stalled over Long Island, dumping more than 13½ inches of rain—nearly an entire summer’s worth—in a matter of hours and breaking the state’s rainfall record. That deluge flooded out over 1,000 homes and businesses, opened massive sinkholes on area roadways, and forced hundreds to evacuate to safer ground. Initial damage estimates exceeded \$30 million.

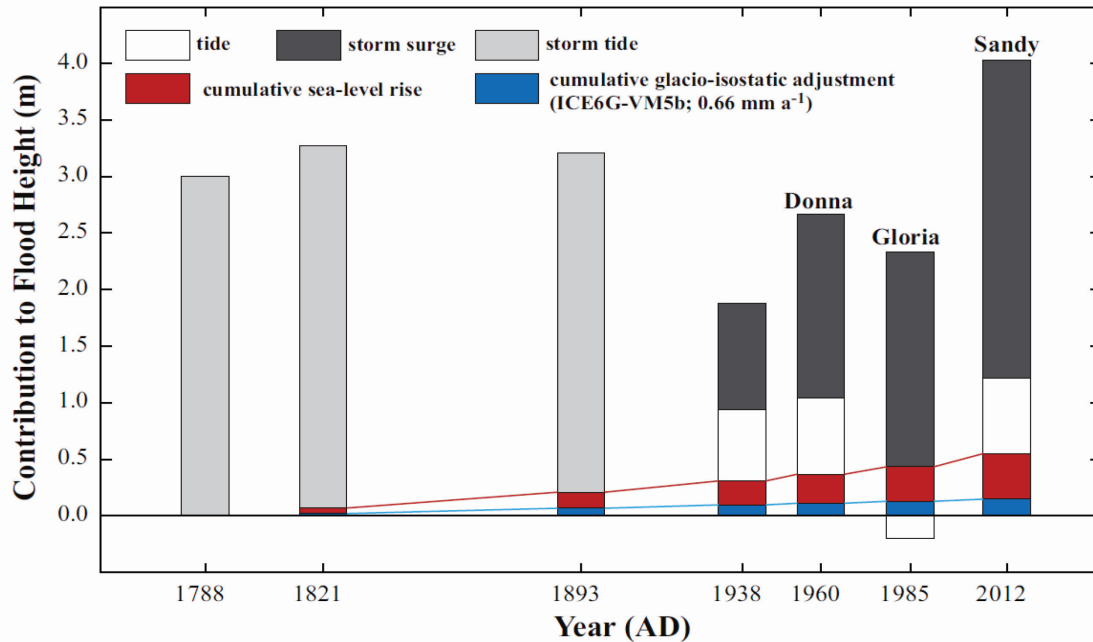
Historic Long Island Flash Flooding



Image from NYTimes (Andrew Theodorakis/Getty Images)

Also, New York’s rate of sea level rise is much higher than the national average and could account for up to 6 feet of additional rise by 2100 if greenhouse gas emissions are not abated. Storm surge on top of high tide on top of sea level rise is a recipe for disaster for coastal New York. The approximately 12 inches of sea level rise New York City has experienced since 1900 may have expanded Hurricane Sandy’s flood area by about 25 square miles, flooding the homes of an additional 80,000 people in the New York City area alone.¹⁷⁴ That flooding devastated areas of New York City, including the Brooklyn-Queens Waterfront, the East and South Shores of Staten Island, South Queens, Southern Manhattan, and Southern Brooklyn, which in some areas lost power and other critical services for extended periods of time.

¹⁷⁴ New York City Panel on Climate Change 2015 Report, Chapter 2: Sea Level Rise and Coastal Storms. Ann. N.Y. Acad. Sci. ISSN 0077-8923, available at: <http://onlinelibrary.wiley.com/doi/10.1111/nyas.12593/full>



**Estimated Contribution to Flood Heights in New York City
for Notable Historical Hurricanes¹⁷⁵**

Hurricane Sandy exposed critical weaknesses in the resilience of New York's utility infrastructure, the danger that this weakness poses to New Yorkers, and the collateral damage to the economy:

- Almost 2 million utility customers suffered from electricity outages;
- Tens of thousands of utility customers were left without power for weeks;
- Hospitals were shut down and patients displaced;
- Many drinking water utilities lost power, which disrupted their ability to provide safe water; and sewage treatment plants could not operate, resulting in billions of gallons of untreated or partially treated sewage flowing into local waterways.

The costs of Hurricane Sandy to New York alone will likely top \$40 billion, including \$32.8 billion to repair and restore damaged housing, parks and infrastructure and to cover economic losses and other expenses. That figure includes \$9.1 billion to help mitigate and prevent potential damages from future severe weather events.¹⁷⁶

Of course, sea level rise will not stop in 2100, nor in 2200 especially if a high GHG emission scenario continues, resulting in locked-in or "committed" sea level rise over hundreds or thousands of years, drastically altering New York's coastline and disrupting our

¹⁷⁵ Kemp et al., Contribution of relative sea-level rise to historical hurricane flooding in New York City, *Journal of Quaternary Science* 28(6), at 537-541 (2013).

¹⁷⁶ See State of New York, *Governor Cuomo Holds Meeting with New York's Congressional Delegation, Mayor Bloomberg and Regional County Executives to Review Damage Assessment for the State in the Wake of Hurricane Sandy*, available at: <https://www.governor.ny.gov/news/governor-cuomo-holds-meeting-new-yorks-congressional-delegation-mayor-bloomberg-and-regional>

communities.¹⁷⁷ The figure below¹⁷⁸ illustrates the inundation in portions of New York City resulting from the committed sea level rise expected from 4°C (7.2°F) of warming.¹⁷⁹ Note that in the ongoing rulemaking for the Safe Vehicles Rule, the National Highway Traffic Safety Administration has determined that taking no policy actions to reduce CO2 emissions will cause global surface temperature in 2100 to increase to 3.48°C¹⁸⁰, close to the 4°C warming represented in the figure.



Although New York has taken a number of actions to reduce pollutants such as nitrogen oxides and volatile organic compounds that contribute to ground level ozone (smog) formation, ozone pollution remains a persistent problem. Much of New York City and Long Island have not attained the 2008 ozone standards, much less the more protective 2015 standards. A significant amount of the pollutants that contribute to smog is generated in upwind states and carried by prevailing winds into New York and other northeastern states. As the climate warms, increased temperatures create more favorable conditions for the formation of smog. According to the Third National Assessment on Climate Change, for example, under a scenario in which greenhouse

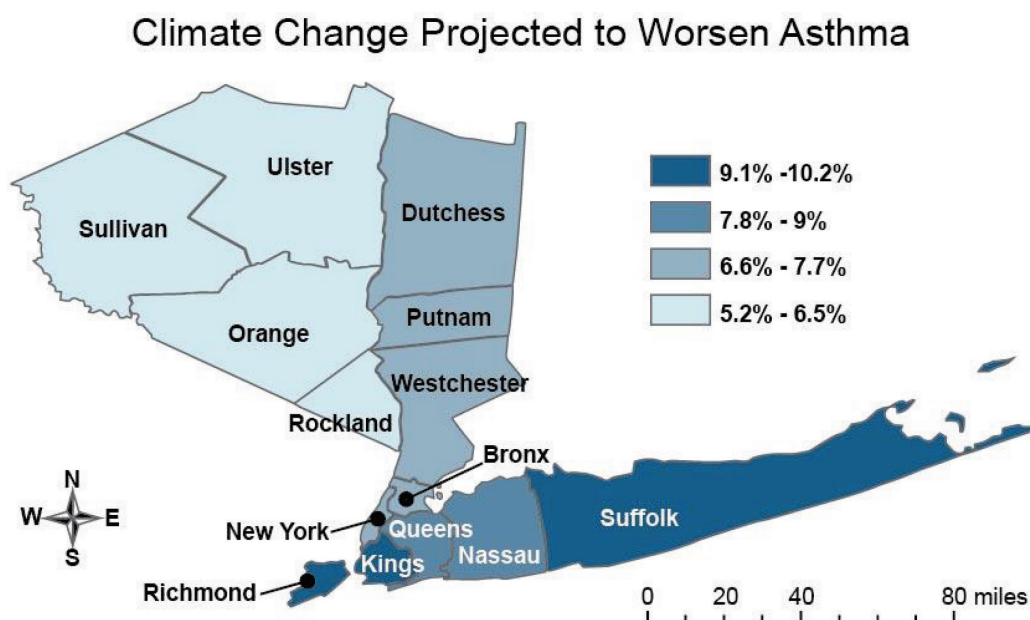
¹⁷⁷ U.S. Global Change Research Program, 2014 National Climate Assessment, at 345.

¹⁷⁸ Data file available at <http://sealevel.climatecentral.org/maps/google-earth-video-global-cities-at-risk-from-sea-level-rise>

¹⁷⁹ Carbon choices determine US cities committed to futures below sea level. Strauss, B.H., S. Kulp, and A. Levermann. PNAS November 3, 2015 112 (44) 13508-13513, available at <https://doi.org/10.1073/pnas.1511186112>

¹⁸⁰ Draft Environmental Impact Statement for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks. NHTSA. July 2018. Docket No. NHTSA-2017-0069. 500 pp.

gases continue to increase, this would lead to higher ozone concentrations in the New York metropolitan region, driving up the number of ozone-related emergency room visits for asthma in the area by 7.3 percent--more than 50 additional ozone-related emergency room visits per year in the 2020s, compared to the 1990s.¹⁸¹ The figure below, included in that report, shows that projected worsening in asthma cases in the New York City area.



North Carolina

The effects of climate change have been felt and will continue to be felt from the mountains to the sea and across every sector of North Carolina's economy.

With approximately 3,375 miles of shoreline,¹⁸² North Carolina is particularly vulnerable to the effects of sea-level rise. In its 2010 Sea Level Rise Assessment Report, the North Carolina Coastal Resource Commission's Science Panel on Coastal Hazards concluded that a 39-inch rise in sea levels was likely to occur on the North Carolina coast in the next century.¹⁸³ The Panel's

¹⁸¹ U.S. Global Change Research Program, *2014 Third National Assessment on Climate Change*, at 222 (citing Sheffield, P. E., J. L. Carr, P. L. Kinney, and K. Knowlton, Modeling of regional climate change effects on ground level ozone and childhood asthma. *American Journal of Preventive Medicine*, 41, 251-257 (2011), available at <http://download.journals.elsevierhealth.com/pdfs/journals/0749-3797/PIIS0749379711003461.pdf>)

¹⁸² NOAA Office for Coastal Management, Shoreline Mileage of the United States, <https://coast.noaa.gov/data/docs/states/shorelines.pdf>.

¹⁸³ N.C. Coastal Resource Commission Science Panel, North Carolina Sea-Level Rise Assessment Report (March 2010), available at

2015 update predicted that sea levels would rise by 1.9 to 10.6 inches at different locations along North Carolina's coast by 2045.¹⁸⁴

Because of eastern North Carolina's low-lying topography, North Carolina faces extensive loss of land to inundation from sea-level rise.¹⁸⁵ In 2014, the North Carolina Division of Emergency Management concluded that over the century, North Carolina could see the inundation of 800 square miles of North Carolina's coastal plain, representing 9% of the land area in North Carolina's 20 coastal counties.¹⁸⁶ Another study predicted that 13 North Carolina communities will face chronic inundation from sea level rise by 2035 and that a further 36 communities will experience chronic inundation by 2100.¹⁸⁷

North Carolina sits within a frequent hurricane path, making its coastal region especially vulnerable to hurricanes and inland flooding. This year, Hurricane Florence claimed the lives of 44 people in North Carolina and caused an estimated \$17 billion in damage.¹⁸⁸ The storm shattered the previous rainfall record set by Hurricane Floyd in 1999 of 24.06 inches. During the hurricane, Elizabethtown, North Carolina saw 35.93 inches of rainfall and Swansboro, North Carolina saw more than 33 inches of rainfall.¹⁸⁹ A rainfall meteorologist at North Carolina State University calculated that Hurricane Florence, compared to all storms in the United States over the last 70 years, produced the second highest amount of rain in a concentrated (14,000 square mile) land area.¹⁹⁰ On the meteorologist's list, four of the top seven storms occurred in the last

https://files.nc.gov/ncdeq/Coastal%20Management/documents/PDF/Coastal%20Hazards%20Storm%20Inundation/NC_Sea_Level_Rise_Assessment_Report_2010_CRC_Science_Panel.pdf.

¹⁸⁴ N.C. Coastal Resource Commission Science Panel, North Carolina Sea-Level Rise Assessment Report: 2015 Update to 2010 Report and 2012 Addendum (March 31, 2015), available at <https://files.nc.gov/ncdeq/Coastal%20Management/documents/PDF/Science%20Panel/2015%20NC%20SLR%20Assessment-FINAL%20REPORT%20Jan%2028%202016.pdf>.

¹⁸⁵ North Carolina Department of Public Safety, North Carolina Emergency Management Geospatial and Technology Management, North Carolina Sea Level Rise Impact Study: Final Study Report (June 2014).

¹⁸⁶ *Id.*

¹⁸⁷ Union of Concerned Scientists, When Rising Seas Hit Home: Fact Sheet: North Carolina Faces Chronic Inundation (July 2017), available at <https://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-northcarolina-fact-sheet.pdf>.

¹⁸⁸ Press Release, North Carolina Governor's Office, Six Months After Florence Made Landfall, North Carolina Continues Work to Rebuild (Mar. 12, 2019), <https://governor.nc.gov/news/six-months-after-florence-made-landfall-north-carolina-continues-work-rebuild>; Press Release, North Carolina Governor's Office, Updated Estimates Show \$17 Billion in Damage (Oct. 31, 2018), <https://governor.nc.gov/news/updated-estimates-show-florence-caused-17-billion-damage>.

¹⁸⁹ WRAL-TV, Record Rainfall: Some Saw Almost 3 Feet from Florence (Sept. 17, 2018), available at <https://www.wral.com/florence-causes-record-rainfall-/17850750/>.

¹⁹⁰ Borenstein, S., Florence Is Nation's Second Wettest Storm, Behind Harvey, WFTV (Sep. 27, 2018), available at <https://www.wftv.com/weather/eye-on-the-tropics/florence-is-nation-s-second-wettest-storm-behind-harvey/842701535>.

three years.¹⁹¹ In 2016, Hurricane Matthew had devastating impacts on many of the same areas of eastern North Carolina, killing at least 27 people and causing some \$1.5 billion in damage, from which the state is still recovering.¹⁹²

The amount of rainfall and flooding these hurricanes have brought used to be extremely rare in North Carolina, but it is not rare anymore. Based on pre-climate change weather patterns, Hurricane Florence's rainfall was described as an event that eastern North Carolina could expect to occur only once every 1000 years.¹⁹³ Hurricane Matthew, a 500-year flood event,¹⁹⁴ hit eastern North Carolina just two years before Florence. As Governor Cooper of North Carolina said, "We have to understand that when you have two so-called 500-year floods within 22 months of each other, [we're] not sure you're talking about [a] 500-year flood anymore. We've got something else on our hands."¹⁹⁵ A third 500-year flood event, caused by Hurricane Floyd, struck eastern North Carolina in 1999.¹⁹⁶ That makes three 500-year (or longer) flood events to hit eastern North Carolina in the past 19 years.

Climate change presents severe health risks for North Carolina's citizens, especially vulnerable populations such as the elderly and children. The North Carolina Department of Health and Human Services has evaluated health risks associated with climate change impacts such as increased drought, increased precipitation, heat waves, hurricanes, and sea-level rise.¹⁹⁷ The health risks associated with these impacts include:

- Waterborne disease outbreaks, increased foodborne illnesses, and compromised drinking water quality.
- Increases in mosquito populations after hurricanes and high rain events.
- Physical injuries caused by hurricanes, flooding, high winds, droughts, and heat waves.
- Respiratory illness caused by prolonged drought periods.

¹⁹¹ *Id.*

¹⁹² Federal Emergency Management Agency, Six Months Following Hurricane Matthew, Volunteers Work for North Carolina Progress (April 6, 2017), *available at* <https://www.fema.gov/news-release/2017/04/06/six-months-following-hurricane-matthew-government-partners-volunteers-work>.

¹⁹³ Risk Management Solutions, Hurricane Florence: Rainfall up to a 1,000-Year Return Period (Sep. 14, 2018), *available at* <https://www.rms.com/blog/2018/09/14/hurricane-florence-rainfall-up-to-a-1000-year-return-period/>.

¹⁹⁴ Office of Water Prediction, National Weather Service, Hurricane Matthew, 6-10 October 2016 Annual Exceedance Probabilities (AEPs) for the Worst Case 24-Hour Rainfall (prepared Oct. 18, 2016), *available at* http://www.nws.noaa.gov/ohd/hdsc/aep_storm_analysis/AEP_HurricaneMatthew_October2016.pdf.

¹⁹⁵ Perchick, M., Florence Flooding: Gov. Cooper Continues Survey of Flood Damage, Announces Housing Assistance Program, WTVD-TV (Sept. 22, 2018), *available at* <https://abc11.com/florence-flooding-gov-cooper-continues-survey-of-flood-damage/4314903/>.

¹⁹⁶ Millner, M., University of North Carolina, Remembering Hurricane Floyd (Oct. 2009), *available at* <https://docsouth.unc.edu/highlights/floyd.html>.

¹⁹⁷ N.C. Department of Health and Human Services, Division of Public Health, North Carolina Climate and Health Profile (March 2015), *available at* <http://epi.publichealth.nc.gov/oeec/climate/ClimateAndHealthProfile.pdf>.

- Lung disease and premature death from heart or lung disease from increased ground-level ozone formed by rising temperatures.¹⁹⁸

Droughts caused by climate change can make a forest more prone to wildfires,¹⁹⁹ creating another major risk to North Carolinians' health. Between October and November of 2016, thirty fires scorched 80,000 acres in drought-stricken western North Carolina counties. State air quality officials detected 24 instances of code orange conditions during the fires, 11 instances of code red, two in code purple and two in code maroon. Fine particulate matter from wildfires is an existing threat to North Carolinians' health, causing increases in respiratory and cardiovascular emergencies in downwind communities.²⁰⁰

Climate change also harms North Carolina's agriculture and agribusiness sector, which is largely based in the eastern part of the state and contributed \$84 billion to North Carolina's economy in 2016.²⁰¹ Major crops include corn, cotton, tobacco, sweet potatoes, pork, turkey, and chicken. Increasingly severe droughts cause crop failures, and higher temperatures reduce livestock productivity.²⁰² Saltwater intrusion from sea level rise can make soils too salty for native plants to grow, impacting crop yields.²⁰³ North Carolina's forestry industry would suffer similar impacts from saltwater intrusion, and increasingly severe and frequent hurricanes would damage North Carolina's forestlands. One study in North Carolina predicted that forest damages rise by \$500 million for every increase in category level of hurricane.²⁰⁴

¹⁹⁸ *Id.*

¹⁹⁹ *Id.*

²⁰⁰ N.C. Department of Health and Human Services, Division of Public Health, North Carolina Climate and Health Adaptation Plan Update (2016), *available at* <http://epi.publichealth.nc.gov/oeec/climate/ClimateAndHealthAdaptationPlan.pdf>.

²⁰¹ Brian Long, Today's Topic: Economic impact of NC agriculture, agribusiness increases to \$84 billion, In the Field, N.C. Dep't of Agriculture and Consumer Services (June 7, 2016), *available at* <http://info.ncagr.gov/blog/2016/06/07/todays-topic-economic-impact-of-nc-agriculture-agribusiness-increases-to-84-billion/>

²⁰² EPA, What Climate Change Means for North Carolina (August 2016), *available at* <https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-nc.pdf>

²⁰³ N.C. Department of Environmental Quality, Division of Coastal Management, Sea Level Rise, <https://deq.nc.gov/about/divisions/coastal-management/coastal-management-hot-topics/sea-level-rise> (last visited Jan. 4, 2018)

²⁰⁴ University of Maryland, Center for Integrative Environmental Research, Economic Impacts of Climate Change on North Carolina (Sept. 2008), *available at* <http://cier.umd.edu/climateadaptation/North%20Carolina%20Economic%20Impacts%20of%20Climate%20Change%20Full%20Report.pdf>.

North Carolina's tourism industry, which generated \$22.9 billion in visitor spending in 2016, is also at risk.²⁰⁵ Tourism is threatened by loss of beach areas due to sea level rise and decrease in demand for coastal travel due to unpredictable weather patterns.²⁰⁶

North Carolina is already incurring significant transportation and infrastructure costs due to climate change impacts. Large numbers of North Carolina's coastal railways, ports, airports, and water and energy supply systems are at low elevations and are therefore vulnerable to the effects of sea level rise and more frequent hurricanes.²⁰⁷ The North Carolina Department of Transportation is raising the roadbed of U.S. Highway 64 across the Albemarle-Pamlico Peninsula by four feet, which includes 18 inches to account for sea level rise.²⁰⁸

Finally, climate change harms North Carolina's tremendous ecological resources, such as its coastal estuaries. North Carolina's coastal estuaries perform essential functions, including filtering pollutants and supporting fisheries.²⁰⁹ Disruption of these important resources from storm damage and salt water intrusion negatively impacts fisheries and depletes water quality.

Oregon

Oregon is already experiencing adverse impacts of climate change and these impacts are expected to become more pronounced in the future, significantly affecting Oregon's economy and environment:

Loss of Snowpack and Drought

The seasonal flow cycles of rivers and streams are changing due to warmer winters and decreased mountain snowpack accumulation, as more precipitation falls as rain, not snow.²¹⁰ The Third Oregon Climate Assessment Report²¹¹ explained that events in 2015 demonstrated the kind of impacts this has already had, and will have in the future:

In 2015, Oregon was the warmest it has ever been since record keeping began in 1895 (NOAA, 2017). Precipitation during the winter of that year was near normal, but winter temperatures that were 5–6°F above average caused the precipitation that did fall to fall

²⁰⁵ North Carolina Tourism Generates Record Employment and Visitor Spending in 2016, Economic Development Partnership of North Carolina (May 8, 2017), *available at* <https://edpnc.com/north-carolina-tourism-generates-record-employment-visitor-spending-2016/>

²⁰⁶ University of Maryland, Economic Impacts of Climate Change on North Carolina, *supra*.

²⁰⁷ EPA, What Climate Change Means for North Carolina, *supra*.

²⁰⁸ U.S. Global Change Research Program, National Climate Assessment (2014), <https://nca2014.globalchange.gov/report/regions/southeast>.

²⁰⁹ N.C. Department of Environmental Quality, Sea Level Rise, *supra*.

²¹⁰ P. Zion Klos et al., *Extent of the Rain-Snow Transition Zone in the Western U.S. Under Historic and Projected Climate*, 41 Geophysical Res. Letters 4560, 4560–68 (2014).

²¹¹ *The Third Oregon Climate Assessment Report*, Oregon Climate Change Research Institute, January 2017.

as rain instead of snow, reducing mountain snowpack accumulation (Mote et al., 2016). This resulted in record low snowpack across the state, earning official drought declarations for 25 of Oregon's 36 counties. Drought impacts across Oregon were widespread and diverse:

Farmers in eastern Oregon's Treasure Valley received a third of their normal irrigation water because the Owyhee reservoir received inadequate supply for the third year in a row (Stevenson, 2016) ...

People near the Upper Klamath Lake were warned not to touch the water as algal blooms that thrived in the low flows and warm waters produced extremely high toxin levels (Marris, 2015) ...

More than half of the spring spawning salmon in the Columbia River perished, likely due to a disease that thrived in the unusually warm waters (Fears, 2015) ...

The West Coast-wide drought developed alongside a naturally-driven large, persistent high-pressure ridge (Wise, 2016). However, anthropogenic warming exacerbated the drought, particularly in Oregon and Washington (Mote et al., 2016; Williams et al., 2015) ...

Oregon's temperatures, precipitation, and snowpack in 2015 are illustrative of conditions that, according to climate model projections, may be considered "normal" by mid-century.²¹²

And there has been more bad news since 2015. In 2018, researcher John Abatzoglou reported that:

Drought impacts are being felt most notably in Oregon, which endured a period of substandard snowpack followed by unusually dry and warm conditions since May. The impacts cover the gamut from fire to farms to fish ...

Fishing restrictions have been enacted in the Umpqua River in western Oregon due to critically warm stream temperatures for steelhead and salmon. The combination of very

²¹² *Id.* at 12-13, citing: P. W. Mote et al., *Perspectives on the causes of exceptionally low 2015 snowpack in the western United States*, (2016); D. Fears, *As salmon vanish in the dry Pacific Northwest, so does Native heritage*, Washington Post (2015); J. Stevenson, *Documenting the Drought*, The Climate CIRCulator (2016); E. Marris, *In the Dry West, Waiting for Congress*, The Klamath Tribes Tribal News and Events (2015); A.P. Williams et al., *Contribution of anthropogenic warming to California drought during 2012-14*, Geophysical Research Letter, 2015.

low flows—including recent daily record low flows—due to subpar precipitation and warm temperatures have allowed water temperatures to warm faster than usual.²¹³

Sea Level Rise

Ocean sea levels will rise between four inches and four-and-a-half feet on the Oregon coast by the year 2100, and coastal residents, cities and towns along Oregon's 300 miles of coastline and 1400 miles of tidal shoreline will be threatened by increased flooding and erosion as a result. Residential development, state highways, and municipal infrastructure are all at risk to such threats.²¹⁴

Ocean Acidification and Hypoxia

As a result of climate change, ocean waters are now more acidified, hypoxic (low oxygen), and warmer, and such impacts are projected to increase, with a particular detrimental impact on some marine organisms like oysters and other shellfish, which will threaten marine ecosystems, fisheries and seafood businesses that play a vital role in Oregon's economy and culture.²¹⁵ As the Third Oregon Climate Assessment Report observed, "[T]he West Coast has already reached a threshold and negative impacts are already evident, such as dissolved shells in pteropod populations ... and impaired oyster hatchery operations ..."²¹⁶

The Oregon Coordinating Council on Ocean Acidification and Hypoxia recently reported that "[n]ew research points to an ever-growing list of marine organisms that are now known to be vulnerable to the threats of ocean acidification and hypoxia (OAH). The list includes species such as Dungeness crabs, rockfishes and salmon that underpin livelihoods and connections to the sea for many Oregonians."²¹⁷

In March of 2017, KVAL TV in Eugene, Oregon chronicled the experience of the Whiskey Creek Hatchery off Netarts Bay in Tillamook, Oregon. Manager Alan Barton said that "[w]e probably produce about a third of all oyster larvae on the West Coast." But in 2007 and 2008, hatchery output collapsed by 75%. Working with scientists from Oregon State University,

²¹³ Abatzoglou, "Drought Returns to the Pacific Northwest," OCCRI Climate Circulator (August 2018).

²¹⁴ See W. Spencer Reeder et al., *Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines*, in *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities* 67–109 (Meghan M. Dalton et al. eds., 2013); Ben Strauss et al., Climate Cent., *California, Oregon, Washington and the Surging Sea: A Vulnerability Assessment with Projections for Sea Level Rise and Coastal Flood Risk* 29 (2014).

²¹⁵ See Francis Chan et al., Cal. Ocean Sci. Tr., *The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions* (2015); Julia A. Ekstrom et al., *Vulnerability and Adaptation of U.S. Shellfisheries to Ocean Acidification*, 5 *Nature Climate Change* 207, 207–14 (2015).

²¹⁶ *Third Oregon Climate Assessment Report*, *supra*, at 36.

²¹⁷ Oregon Coordinating Council on Ocean Acidification and Hypoxia, 1st Biennial Report, at 8, September 15, 2018.

Whiskey Creek identified ocean acidification as the problem. They developed a way to treat the water at the hatchery, which has been successful. But Barton does not believe that treatment is a long-term solution:

“The short term prospects are pretty good. But within the next couple of decades we’re going to cross a line I don’t think we’re going to be able to come back from,” he says. “A lot of people have the luxury of being skeptics about climate change and ocean acidification. But we don’t have that choice. If we don’t change the chemistry of the water going into our tanks, we’ll be out of business. It’s that simple for us.”²¹⁸

Forests, Pests and Fires

Oregon is largely defined by its iconic forests, which climate change threatens in a myriad ways, as the Third Oregon Climate Assessment Report detailed:

Future warming and changes in precipitation may considerably alter the spatial distribution of suitable climate for many important tree species and vegetation types in Oregon by the end of the 21st century. Changing climatic suitability and forest disturbances from wildfires, insects, diseases, and drought will drive changes to the forest landscape in the future. Conifer forests west of the Cascade Range may shift to mixed forests and subalpine forests would likely contract. Human-caused increases in greenhouse gases are partially responsible for recent increases in wildfire activity. Mountain pine beetle, western spruce budworm, and Swiss needle cast remain major disturbance agents in Oregon’s forests and are expected to expand under climate change. More frequent drought conditions projected for the future will likely increase forest susceptibility to other disturbance agents such as wildfires and insect outbreaks.

Future warming and changes in precipitation may considerably alter the spatial distribution of suitable climate for many important tree species and vegetation types in Oregon by the end of the 21st century (Littell et al., 2013). Furthermore, the cumulative effects of changes due to wildfire, insect infestation, tree diseases, and the interactions between them, will likely dominate changes in forest landscapes over the coming decades (Littell et al., 2013). ..

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States, particularly in forested ecosystems (Dennison et al., 2014; Jolly et al., 2015; Westerling, 2016; Williams and Abatzoglou, 2016). The lengthening of the fire season is largely due to declining mountain snowpack and earlier spring snowmelt (Westerling, 2016). In the Pacific Northwest, the fire season length increased over each of the last four decades, from 23 days in the 1970s, to 43 days in the 1980s, 84 days in the 1990s, and

²¹⁸ KVAI-TV, ‘*One morning we came in and everything was dead*’: Climate Change and Oregon oysters, March 1, 2017.

116 days in the 2000s (Westerling, 2016). Recent wildfire activity in forested ecosystems is partially attributed to human-caused climate change: during the period 1984–2015, about half of the observed increase in fuel aridity and 4.2 million hectares (or more than 16,000 square miles) of burned area in the western United States were due to human-caused climate change (Abatzoglou and Williams, 2016).²¹⁹

Health Effects

An increase in forest fire activity is one of the various ways in which climate change threatens human health. As the Third Oregon Climate Assessment noted, “Climate change threatens the health of Oregonians. More frequent heat waves are expected to increase heat-related illnesses and death. More frequent wildfires and poor air quality are expected to increase respiratory illnesses.”²²⁰ For example:

Climate change is expected to worsen outdoor air quality. Warmer temperatures may increase ground level ozone pollution, more wildfires may increase smoke and particulate matter, and longer, more potent pollen seasons may increase aeroallergens (Fann et al., 2016). Such poor air quality is expected to exacerbate allergy and asthma conditions and increase respiratory and cardiovascular illnesses and death (Fann et al., 2016).²²¹

Oregon has already experienced a dramatic increase in “unhealthy air days” due to forest fires. The Medford metro region experienced 20 air quality alert days due to fire from 1985 through 2001, 19 of those in one year. From 2002 through 2012, Medford had 22 such days. But since 2013, Medford has had 74 such days, including 20 in 2017 and 35 in 2018.²²² Portland, meanwhile, had a total of two such days from 1985 through 2014 – but 13 such days from 2015 through 2018.²²³

²¹⁹ *The Third Oregon Climate Assessment Report*, citing J.T. Abatzoglou and A.P. Williams, *Impact of anthropogenic climate change on wildfire across western US forests.*, Proceedings of the National Academy of Sciences 113 (2016); P.E. Dennison et al, *Large wildfire trends in the western United States, 1984–2011*, Geophysical Research Letters 41 (2014); J.S.D. Littell et al., *Forest ecosystems: Vegetation, disturbance, and economics*, Chapter 5. In: Dalton, Mot, and Snover(eds) *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, Island Press, Washington, DC (2013); A. L. Westerling, *Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring*. Phil. Trans. R. Soc. B 371 (2016).

²²⁰ *Third Oregon Climate Assessment Report*, *supra*, at 74.

²²¹ *Id.*, citing N. Fann et al., Ch. 3: *Air Quality Impacts. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. US Global Change Research Program*, Washington, DC (2016).

²²² In addition to the impact on human health, fires in the Medford area have punished a beloved Oregon institution, the Oregon Shakespeare Festival in Ashland. In 2018 alone, the Festival had to cancel – or move indoors, to smaller venues – 20 performances, costing the Festival money and ruining many theater-goers’ plans. *Wildfire Smoke Disrupts Oregon Shakespeare Festival*, New York Times, August 24, 2018.

²²³ Oregon DEQ, *Forest Fire Smoke Impact on Air Quality Health Trends in Bend, Klamath Falls, Medford, and Portland (1985 to 2018)*, DEQ18-NWR-0066-TR (October 2018). It is worth noting

During the 2017 Eagle Creek fire, the Oregon Health Authority (OHA) reported a 29% increase in emergency room visits for respiratory symptoms in the Portland metro region.²²⁴

In its 2014 Oregon Climate and Health Profile Report, OHA elaborated on the health effects of wildfire smoke:

Particulate matter (PM) in smoke from wildfires is associated with cancer, cardiopulmonary disease and respiratory illness ... As a result of projected increases in wildfire, Spracklen et al. (2009) anticipate an increase in aerosol organic carbon of up to 40% and an increase in elemental carbon in the western U.S. of up to 20% in 2046–2055 compared to 1996–2005 ... PM associated with wildfires in California has been shown to be more toxic to the lungs than normal ambient PM ... PM exposure from wildfire smoke is a risk beyond the immediate area of the fire, since high winds can carry the PM long distances ... Increases in smoke are associated with hospital admissions for respiratory complaints, and long-term exposure worsens existing cardiopulmonary disease ... bronchitis and pneumonia.²²⁵

Impact on American Indian Tribes

As the Legislative Summary of the Third Oregon Climate Assessment Report observed:

Changes in terrestrial and aquatic ecosystems will affect resources and habitats that are important for the sovereignty, culture, economy, and community health of many American Indian tribes. Tribes that depend upon these ecosystems, both on and off reservation, are among the first to experience the impacts of climate change. Of particular concern are changes in the availability and timing of traditional foods such as salmon,

that although air quality alerts are often limited to especially vulnerable populations – “unhealthy for sensitive groups” – Medford in 2017-18 has experienced 38 days in which the air was unhealthy for all populations, including five “very unhealthy” days and one “hazardous” day.

²²⁴ Statewide Fire Activation Surveillance Report (090517-090617), Oregon Health Authority.

²²⁵ Oregon Climate and Health Profile Report at 39 (Oregon Health Authority, Public Health Division, 2014), citing C.A. Pope et al., *Cardiovascular mortality and long-term exposure to particulate air pollution: Epidemiological evidence of general pathophysiological pathways of disease*, *Circulation*. 2004;109:71–7.; C.A. Pope and D.Q. Dockery, Dockery, *Health effects of fine particulate air pollution: lines that connect.*, *Journal of the Air & Waste Management Association* (1995). 2006;56:709–42; World Health Organization. *Review of Evidence on Health Aspects of Air Pollution–REVIHAAP Project* (2013.) J.L. Mauderly and J.C. Chow, *Health effects of organic aerosols. Inhalation toxicology*. 2008;20:257–88; T.C. Wegesser and K.E. Pinkerton KE, J.A. Last, *California wildfires of 2008: coarse and fine particulate matter toxicity*, *Environmental Health Perspectives*. 2009;117:893–7.; M. Ginsberg et al. *Monitoring Health Effects of Wildfires Using the BioSense System--San Diego County, California*, October 2007. *Morbidity and Mortality Weekly Report*. 2008;57(27):741–4; R.J. Delfino et al., *The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003*, *Occupational and Environmental Medicine*. 2009;66:189–97.

shellfish, and berries, and other plant and animal species important to tribes' traditional way of life.²²⁶

The threat that climate change poses to salmon populations is a particular source of concern for the tribes:

A 2015 study of Columbia River Basin tribes, including the Confederated Tribes of Warm Springs (CTWS) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), found that the primary concerns regarding climate change impacts included the quantity and quality of water resources, snowpack, water temperatures for spawning conditions, and fishing rights (Sampson, 2015). Pacific salmon have great cultural, subsistence, and commercial value to tribes in the Pacific Northwest, and are central to tribal cultural identity, longhouse religious services, sense of place, livelihood, and the transfer of traditional values to the next generation (Dittmer, 2013). During the last 150 years, culturally important salmon populations have declined (Dittmer, 2013). Continuation of past trends of earlier spring peak, more extreme high flows and more frequent low flows in the low elevation basins of northeast Oregon, home to the CTWS and CTUIR, may force earlier migration of juvenile salmon, challenge returning adults in low flow conditions, and increase scour risk for emerging young salmon (Dittmer, 2013).²²⁷

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The threat that climate change poses to forests is likewise a major concern for tribes:

Changes in forest ecosystems and disturbances will affect resources and habitats that are important for the cultural, medicinal, economic, and community health of tribes (Lynn et al., 2013). In Oregon, 62% of tribal reservation land is forested, and the US government has a trust responsibility toward such forests (Indian Forest Management Assessment Team, 2013). American Indian and Alaska Native tribes that depend on forest ecosystems, whether on or off reservations, are among the first to experience the impacts that climate change is having on forests, such as the expansion of invasive species, insects, diseases, and wildfires (Norton-Smith et al., 2016). Invasive species that displace native species can negatively affect tribal subsistence and ceremonial practices, although there is little knowledge about on how climate change will interact with invasive species (Norton-Smith et al., 2016). Increasing wildfire, insects, and diseases have jeopardized the economic and ecological sustainability of tribally managed forests and important tribal resources (Indian Forest Management Assessment Team, 2013; Norton-Smith et al., 2016). Collaborative adaptive forest management that integrates tribal traditional

²²⁶ *The Third Oregon Climate Assessment Report, supra*, (Legislative Summary).

²²⁷ K. Dittmer, *Changing streamflow on Columbia basin tribal lands—climate change and salmon*, Climatic Change 120(3) (2013); D. Sampson, *Columbia River Basin Tribes Climate Change Capacity Assessment*, Institute for Tribal Government, Hatfield School of Government, Portland State University: Portland, OR (2015)

ecological knowledge can support socio-ecological resilience to climate change (Armatas et al., 2016).²²⁸

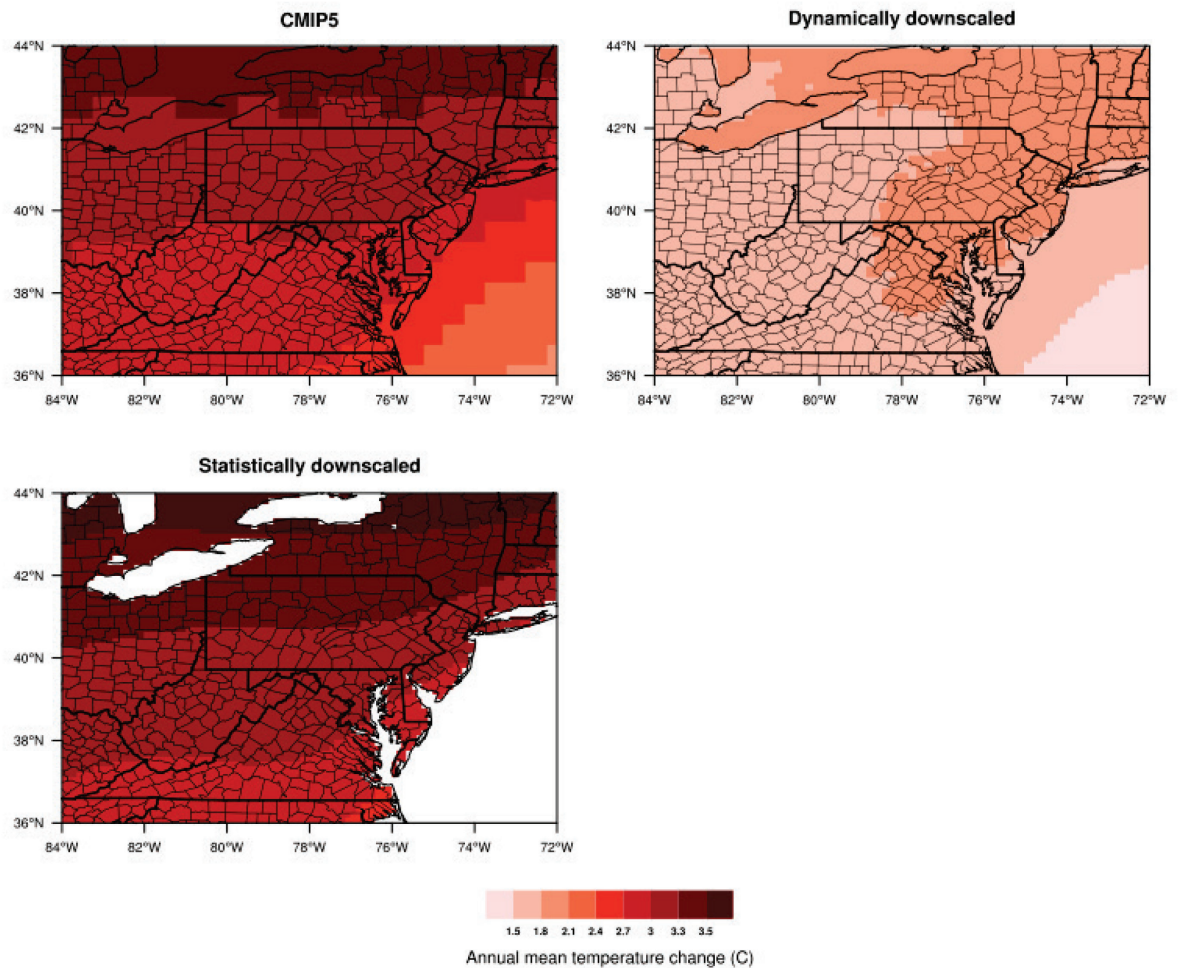
Pennsylvania

The Commonwealth of Pennsylvania faces two fundamental threats related to climate: (1) sea level rise and its impact on communities and cities in the Delaware River Basin, including the city of Philadelphia; and (2) more frequent extreme weather events, including large storms, periods of drought, heat waves, heavier snowfalls, and an increase in overall precipitation variability. Based on studies commissioned by the Pennsylvania Department of Environmental Protection, as part of its mandate under the Pennsylvania Climate Change Act, 71 P.S. §§ 1361.1 – 1361.8, Pennsylvania has undergone a long-term warming of more than 1°C over the past 110 years.²²⁹ The models used in the 2015 Climate Impacts Assessment Update suggest this warming is a result of anthropogenic influence, and that this trend is accelerating. Projections in the 2015 Update show that by the middle of the 21st century, Pennsylvania will be about 3°C warmer than it was at the end of the 20th century.

²²⁸ Citing C. Armatas et al., *Opportunities to utilize traditional phenological knowledge to support adaptive management of social-ecological systems vulnerable to changes in climate and fire regimes*, Ecology and Society 21 (2016) ; *Assessment of Indian Forests and Forest Management in the United States*, Indian Forest Management Assessment Team (2013) ; K. Lynn et al., *Northwest Tribes: Cultural Impacts and Adaptation Resources*: Chapter 8. In: M. M. Dalton et al., *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, Island Press: Washington, DC (2013),; K. Norton-Smith et al., *Climate change and indigenous peoples: a synthesis of current impacts and experiences* (2016). .

²²⁹ See “Pennsylvania Climate Impacts Assessment Update,” May 2015, available at <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-108470/2700-BK-DEP4494.pdf>. See also “Pennsylvania Climate Impacts Assessment Update,” October 2013, available at <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-97037/PA%20DEP%20Climate%20Impact%20Assessment%20Update.pdf>; “Pennsylvania Climate Assessment,” June 2009, available at <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-75375/7000-BK-DEP4252.pdf>.

Model mean temperature change



Modeling charts from the 2015 Update show that in both the CMIP5 and statistically downscaled CMIP5 datasets, mid-century temperatures in the Philadelphia region are projected to be similar to historical temperatures in the Richmond, VA area. Similarly, Pittsburgh's temperatures are projected to resemble the historically observed temperatures in the Baltimore-Washington area. The mean warming across the state simulated by these models is generally 3.0-3.5 °C (5.4-6.3°F). The CMIP5 model mean change is 3.0-3.3 °C (5.4-6.0 °F) across nearly the entire state. The statistically downscaled CMIP5 model mean change is 3.3-3.5 °C (5.9-6.3°F) in the northern half of the state and 3.0-3.3 °C (5.4-6.0°F) in the southern half. Finally, the dynamically downscaled dataset model mean change is only 1.5-1.8 °C (2.7-3.2°F) across the western half of the state and 1.8-2.1 °C (3.2-3.8 °F) across the eastern half. The reduced warming is likely at least partially because these models rely on a different emissions scenario, in which the buildup of greenhouse gases in the atmosphere occurs at a slower rate than in the than in the scenarios that the CMIP5 models use.

The 2015 Climate Impacts Assessment Update also finds that this warming trend will threaten Pennsylvania in other ways:

- Pennsylvania agriculture will have to adapt to by greater extremes in temperature and precipitation.²³⁰ Pennsylvania dairy production is likely to be negatively affected by climate change due to losses in milk yields caused by heat stress, additional energy and capital expenditures to mitigate heat stress, and lower levels of forage quality.
- Pennsylvania's forests will be subject to multiple stressors.²³¹ The warming climate will cause tree species inhabiting decreasingly suitable habitat to become stressed. Mortality rates are likely to increase and regeneration success is expected to decline for these tree species, resulting in declining importance of those species in the state.
- Suitable habitat for plant and wildlife species is expected to shift to higher latitudes and elevations.²³² This will reduce the amount of suitable habitat in Pennsylvania for species that are at the southern extent of their range in Pennsylvania or that are found primarily at high latitudes; the amount of habitat in the state that is suitable for species that are at the northern extent of their range in Pennsylvania will increase. The Canada lynx, which is already rare in Pennsylvania, will likely be extirpated from the state.
- The public health of Pennsylvanians is threatened because climate change will worsen air quality relative to what it would otherwise be, causing increased respiratory and cardiac illness.²³³ The linkage between climate change and air quality is most strongly established for ground-level ozone creation during summer, but there is some evidence that higher temperatures and higher precipitation will result in increased allergen (pollen and mold) levels as well.
- West Nile disease is endemic in Pennsylvania.²³⁴ It is currently most prevalent in Southeastern and Central parts of the state, and less prevalent in the Laurel Highlands and the Allegheny Plateau. However, climate change is expected to increase the prevalence of West Nile disease in the higher-elevation areas, due to higher temperatures. In addition to its range, the duration of the transmission season for West Nile disease is sensitive to climate. Warmer temperatures result in a longer transmission season, and therefore greater infection risk.
- Climate change will have a severe, negative impact on winter recreation in Pennsylvania.²³⁵ Downhill ski and snowboard resorts are not expected to remain economically viable past mid-century. Snow cover to support cross country skiing and

²³⁰ 2015 Climate Impacts Assessment Update, *supra*, at 63.

²³¹ *Id.* at 114.

²³² *Id.*

²³³ *Id.* at 321.

²³⁴ *Id.* at 135.

²³⁵ *Id.* at 141.

snowmobiling has been declining in Pennsylvania, and is expected to further decline by 20-60%, with greater percentage decreases in southeastern Pennsylvania, and smaller decreases in northern Pennsylvania.

- Climate change poses a threat to the fauna of the tidal freshwater portion of the Delaware estuary in Pennsylvania.²³⁶ One reason is that increased water temperatures with climate change decrease the solubility of oxygen in water and will increase respiration rates, both of which will result in declines in dissolved oxygen concentration. Thus, climate change will worsen the currently substandard water quality in the tidal freshwater region of the Delaware Estuary.
- The freshwater tidal wetlands along Pennsylvania's southeastern coast are a rare, diverse, and ecologically important resource.²³⁷ Climate change poses a threat to these wetlands because of salinity intrusion and sea-level rise. Sea-level rise, however, has the potential to drown wetlands if their accretion rates are less than rates of sea-level rise.

Rhode Island

Climate change is adversely impacting Rhode Island in many diverse ways, including warming air temperatures, warming ocean temperatures, rising sea level, increased acidity of ocean waters, increased rainfall amounts, and increased intensity of rainfall events.

Rhode Island has experienced a significant trend over the past 80 years toward a warmer and wetter climate. Trends are evident in annual temperatures, annual precipitation, and the frequency of intense rainfall events. Temperatures have been steadily climbing in the Ocean State since the early 1930s. The average annual temperature for the state is currently increasing at a rate of 1 degree Fahrenheit every 33 years. The frequency of days with high temperatures at or above 90 degrees has increased while the frequency of days with minimum temperatures at or below freezing has decreased.²³⁸

There has also been a pronounced increase in precipitation from 1930 to 2013. Increased precipitation has occurred as a result of large, slow moving storm systems, multiple events in the span of a few weeks (such as the 2010 spring floods), as well as an increase in the frequency of intense rain events. The average annual precipitation for Rhode Island is increasing at a rate of

²³⁶ *Id.* at 152.

²³⁷ *Id.*

²³⁸ *Overview of a Changing Climate in Rhode Island*, David Vallee (Hydrologist-in-Charge, National Weather Service Northeast River Forecast Center, NOAA) and Lenny Giuliano (Air Quality Specialist, Rhode Island Department of Environmental Management, State Climatologist, State of Rhode Island), August 2014 at 2-3, available at http://research3.fit.edu/sealevelriselibrary/documents/doc_mgr/444/Valee%20&%20Giuliano.%202014.%20CC%20in%20Rhode%20Island%20Overview.pdf.

more than 1 inch every 10 years. The frequency of days having one inch of rainfall has nearly doubled. Intense rainfall events (heaviest 1 percent of all daily events from 1901 to 2012 in New England) have increased 71 percent since 1958. The increased amounts of precipitation since 1970 has resulted in a much wetter state in terms of soil moisture and the ground's ability to absorb rainfall.²³⁹

In addition, the water in Narragansett Bay is getting warmer. Over the past 50 years, the surface temperature of the Bay has increased 1.4° to 1.6° C (2.5° to 2.9° F). Winter water temperatures in the Bay have increased even more, from 1.6° to 2.0° C (2.9° to 3.6° F). Ocean temperatures are increasing world-wide, but temperature increases in the northwestern Atlantic Ocean are expected to be 2-3 times larger than the global average.²⁴⁰ Warmer water temperatures in Narragansett Bay are causing many changes in ecosystem dynamics, fish, invertebrates, and plankton. Cold-water iconic fishery species (cod, winter flounder, hake, lobster) are moving north out of RI waters and warm-water southern species are becoming more prevalent (scup, butterfish, squid). Rhode Island's marine waters are also becoming more acidic due to increasing CO₂. This may cause severe impacts to shellfish, especially in their larval life stages.²⁴¹

Sea levels have risen over 9 inches in Rhode Island since 1930 as measured at the Newport tide gauge. The historic rate of sea level rise at the Newport tide gauge from 1930 to 2015 is presently 2.72 mm/year, or more than an inch per decade.²⁴² At present rates, sea levels will likely increase 1 inch between every 5 or 6 years in Rhode Island. NOAA is projecting as much as 6.6 feet of sea level rise by the end of this century in Rhode Island. In the shorter-term, NOAA predicts upwards of 1 foot by 2035 and 1.9 feet by 2050.²⁴³ This has critical implications for Rhode Island, as thousands of acres of Rhode Island's coast will be affected.

Climate change is also altering the ecology and distribution of plants and animals in Rhode Island. In southern New England, spring is arriving sooner and plants are flowering earlier (one week earlier now when compared to the 1850s). For every degree of temperature rise in the spring and winter, plants flower 3.3 days earlier. For woody plants, leaf-out is occurring 18 days earlier now than in the 1850s. Changes in the timing of leaf-out, flowering, and fruiting in plants can be very disruptive to plant pollinators and seed dispersers.²⁴⁴

Changes in the timing of annual cycles has been observed in Rhode Island birds. Based on a 45-year near-continuous record of monitoring fall migration times for passerine birds in

²³⁹ *Id.* at 4.

²⁴⁰ Rhode Island Executive Climate Change Coordinating Council (EC4) Science and Technical Advisory Board (STAB) Annual Report to the Full Council of the EC4 (May 2016), appendix to Rhode Island Executive Climate Change Coordinating Council Annual Report, June 2016, at 33-35, available at <http://climatechange.ri.gov/documents/ar0616.pdf>.

²⁴¹ *Id.*

²⁴² *Id.* at 28-30.

²⁴³ *Id.*

²⁴⁴ *Id.* at 38-40

Kingston, RI, Smith and Paton (2011) found a 3.0 days/decade delay in the departure time of 14 species of migratory birds.²⁴⁵

Vermont

Climate change is causing an increase in temperatures and precipitation in Vermont. Average annual temperature has increased by 1.3° F since 1960, and is projected to rise by an additional 2-3.6 ° F by 2050.²⁴⁶ Since 1960, average annual precipitation has increased by 5.9 inches.²⁴⁷

Heavy rainfall events are becoming more common.²⁴⁸ Increasingly frequent heavy rains threaten to flood communities located in Vermont's many narrow river valleys. In 2011 Tropical Storm Irene dumped up to 11 inches of rain on Vermont, impacting 225 municipalities and causing \$733 million in damage.²⁴⁹ More than 1,500 residences sustained significant damage, temporarily or permanently displacing more than 1400 households.²⁵⁰ More than 500 miles of state highway, 2000 municipal road segments, and 480 bridges were damaged.²⁵¹ Farms, water supply and wastewater treatment facilities were also damaged, and the channels of many streams were enlarged and/or relocated.²⁵²

In addition to threatening human lives and property, increasingly frequent heavy rains present challenges for state and local land use planning. Further, storm water runoff carries pollutants to the state's streams and lakes, and hinders the state's efforts to address phosphorous pollution and resulting algal blooms in Lake Champlain.

Climate change also threatens Vermont's environment and economy by affecting activities dependent on seasonal climate patterns, such as maple sugaring and winter sports.²⁵³

²⁴⁵ *Id.*

²⁴⁶ *Vermont Climate Change Assessment*, <http://vtclimate.org/vts-changing-climate/> (last visited Oct. 24, 2018).

²⁴⁷ *Id.*

²⁴⁸ *Id.*

²⁴⁹ Pierre-Louis, Kendra, *Five Years After Hurricane Irene, Vermont Still Striving for Resilience*, Inside Climate News (Sept. 1, 2016), available at <https://insideclimatenews.org/news/31082016/five-years-after-hurricane-irene-2011-effects-flooding-vermont-damage-resilience-climate-change>.

²⁵⁰ *Tropical Storm Irene by the Numbers* (Aug. 28, 2013), <http://www.vermontbiz.com/news/august/tropical-storm-irene-numbers> (last visited Oct. 24, 2018).

²⁵¹ *Id.*

²⁵² *Id.*

²⁵³ U.S. EPA, *What Climate Change Means for Vermont* (August 2006), available at <https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-vt.pdf>.

Vermont is the nation's leading maple-syrup producing state²⁵⁴. Warmer temperatures are likely to shift the suitable habitat for sugar maples farther north into Canada.²⁵⁵ Warmer winters may bring more rain and less snow to Vermont, harming the skiing, snowboarding, and snowmobiling industries and local economies that depend on them. *Id.* During the winter of 2016-17, Vermont recorded more than 3.9 million skier visits, second only to Colorado among the states.²⁵⁶

Climate change is also contributing to increased distribution and abundance of ticks and increased tickborne diseases, including Lyme disease and Anaplasmosis, in Vermont.²⁵⁷ Vermont has the nation's highest per-capita incidence of Lyme Disease.²⁵⁸

Virginia

It's not a question of if or when; Virginia is currently experiencing the effects of climate change. Virginia's low-lying coastline is especially vulnerable to this threat. Virginia has experienced the highest rates of sea level rise along the East Coast: in Virginia Beach, the sea has risen by almost a foot since the 1960s²⁵⁹ and more than 14 inches since 1930.²⁶⁰ Ordinary rain events now cause flooding in the streets of Norfolk, including large connector streets going underwater.²⁶¹ Norfolk naval base, the largest navy base in the world, currently is "one of the most vulnerable to flooding" military installations in the U.S., as relative sea-level rise

²⁵⁴Vermont Agency of Agriculture Food & Markets, *Vermont Leads Nation in 2018 Maple Season Production* (June 13, 2018), <http://agriculture.vermont.gov/Vermont%20Leads%20Nation%20in%202018%20Maple%20Season%20Production> (last visited Oct. 24, 2018).

²⁵⁵ U.S. EPA, *What Climate Change Means for Vermont*, *supra*.

²⁵⁶*Vermont ski industry rebounds to nearly 4 million visits*, Vermontbiz (June 15, 2017), <https://vermontbiz.com/news/june/vermont-ski-industry-rebounds-nearly-4-million-visits> (last visited Oct. 24, 2018).

²⁵⁷ Vermont Department of Health, *Climate Change and Tickborne Diseases*, <http://www.healthvermont.gov/health-environment/climate-health/tickborne-diseases> (last visited Oct. 24, 2018).

²⁵⁸ DeSmet, Nicole, *Tick-borne diseases: Getting worse, CDC study finds*, Burlington Free Press (May 9, 2018), available at <https://www.burlingtonfreepress.com/story/news/local/vermont/2018/05/09/tick-spreading-lyme-diseases-getting-worse-cdc-study-finds/589714002/>.

²⁵⁹ City of Virginia Beach, *Comprehensive Sea Level Rise*, <https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Pages/default.aspx> (last visited Oct. 24, 2018).

²⁶⁰ Chesapeake Bay Foundation, *Sea Level Rise: Finding Nature-Based Solutions to Sea Level Rise*, <http://www.cbf.org/issues/climate-change/sea-level-rise.html> (last visited Oct. 24, 2018).

²⁶¹ Gregory, Matt, *Rain causes Norfolk streets and neighborhoods to flood*, WAVY-TV (Sept. 21, 2016), available at <http://wavy.com/2016/09/21/rain-causes-norfolk-streets-and-neighborhoods-to-flood/>

contributes to “more frequent nuisance flooding and increased vulnerability to coastal storms.”²⁶² According to Old Dominion University’s Center for Sea Level Rise, the city of Norfolk alone will need at least \$1 billion in the coming decades to replace current infrastructure and keep water out of city homes and businesses.²⁶³ According to a recent study by the Hampton Roads Planning District Commission, costs from three feet of sea-level rise in the Hampton Roads region are expected to range between \$12 billion and \$87 billion.²⁶⁴ Climate change has lengthened Virginia’s allergy season and facilitated the spread of tick and mosquito borne illnesses—the ticks carrying Lyme disease are now reported in at least 72 counties, up from 12 counties in 1996.²⁶⁵ These direct results of climate change generate negative impacts on Virginians, their quality of living, and their pocketbooks. Environmental impacts have direct and immediate negative economic results.

Washington

Washington is a coastal state, a mountain state, and a forest state. Reports prepared by the University of Washington Climate Impacts Group show that climate change will significantly adversely affect each of these signature features of Washington. In addition to these impacts, climate change will cause significant harm to public health.

Approximately 4 million of Washington’s 6.5 million people live in the area around Puget Sound. Climate change will cause the sea level to rise and permanently inundate low-lying areas in the Puget Sound region.²⁶⁶ Under a business as usual greenhouse gas scenario, sea level is predicted to rise in Seattle relative to 2000 levels by 2 feet by 2050 and 5 feet by 2100.²⁶⁷ Sea level rise will also increase the frequency of coastal flood events. For example, with 2 feet of sea level rise (predicted for Seattle), a 1-in-100 year flood event will become an annual event. Sea level rise will also cause coastal bluffs (the location of many family homes in Puget Sound) to

²⁶² U.S. Dept. of Defense, Report on Effects of a Changing Climate to the Department of Defense” (Jan. 2019), <https://www.documentcloud.org/documents/5689153-DoD-Final-Climate-Report.html>.

²⁶³ Center for Sea Level Rise, Old Dominion University, "Center For Sea Level Rise" (2017). *Hampton Roads Intergovernmental Pilot Project: Website*. 1, available at http://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1000&context=hripp_website.

²⁶⁴ *Id.*

²⁶⁵ National Resources Defense Council, *Climate Change and Health in Virginia* (April 2018) available at <https://assets.nrdc.org/sites/default/files/climate-change-health-impacts-virginia-ib.pdf>

²⁶⁶ U.S. Census Bureau, *Annual Estimates of the Population of Combined Statistical Areas: April 2010 to July 2011*, U.S. Census Bureau, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_B01003&prodType=table (last visited Oct. 24, 2018).

²⁶⁷ State of Knowledge: Climate Change in Puget Sound (November 2015), Climate Impacts Group, University of Washington, (hereinafter “State of Knowledge, Puget Sound”) at 4-7; available at <https://cig.uw.edu/resources/special-reports/ps-sok/>

recede by as much as 75-100 feet by 2100 relative to 2000.²⁶⁸ This would be a doubling, on average, of the current rate of recession. Sea level rise will also result in reduced harvest for commercial fishing and shellfish operations.²⁶⁹

Climate change is also causing ocean acidification, through the absorption in the ocean of excess carbon dioxide from the atmosphere. Ocean waters on the outer coast of Washington and the Puget Sound have become about 10-40 percent more acidic since 1800.²⁷⁰ This increased acidity is already affecting some shellfish species.²⁷¹ Washington has the largest shellfish industry on the west coast, contributing \$184 million to Washington's economy in 2010 and employing 2710 workers.²⁷² Under a business as usual greenhouse gas scenario, ocean waters are expected to become at least 100 percent more acidic by 2100 relative to 1986-2005.²⁷³ The predicted level of ocean acidification is expected to cause a 34 percent decline in shellfish survival by 2100.²⁷⁴

Washington depends on yearly winter mountain snow pack for drinking water, as well as water for irrigation, hydropower, and salmon. Washington's winter mountain snowpack is decreasing because climate change is causing more precipitation to fall as rain rather than snow. Snowpack decreased in Washington's Cascade Mountains by about 25 percent between the mid-20th century and 2006.²⁷⁵ By the 2040s, snowpack is predicted to decrease 38-46 percent relative to 1916-2006,²⁷⁶ and by the 2080s, snow pack is expected to decline 56-70 percent.²⁷⁷ This loss of snowpack will cause a 50 percent increase in the number of years in which water is not available for irrigation, as well as a 20 percent decrease in summer hydropower production.²⁷⁸ In addition, the decrease in summer stream flows combined with higher stream temperatures will result in stream temperatures too high to support adult salmon.²⁷⁹

²⁶⁸ *Id.*

²⁶⁹ *Id.*

²⁷⁰ State of Knowledge Report, Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers, (December 2013), Climate Impacts Group, University of Washington (hereinafter "State of Knowledge Report"), at 2-6; available at <https://cig.uw.edu/resources/special-reports/wa-sok/>

²⁷¹ *Id.* at 2-3.

²⁷² Washington: A Shellfish State, Washington Shellfish Initiative, at <http://www.governor.wa.gov/sites/default/files/WSI%20factsheet.pdf>

²⁷³ State of Knowledge Report at ES-2.

²⁷⁴ *Id.* at 8-4.

²⁷⁵ *Id.* at 2-5

²⁷⁶ *Id.* at ES-2.

²⁷⁷ *Id.* at 6-10.

²⁷⁸ *Id.* at 6-5.

²⁷⁹ *Id.* at ES-4, 6-6, 6-11, 6-12.

Climate change is also impacting Washington's forests. Of Washington's total area (42.5 million acres), a little more than half (22 million acres) is forested.²⁸⁰ Washington's forest products industry generates a gross income of about \$48 billion per year, provides more than 100,000 jobs, and contributes approximately \$4.9 billion in annual wages.²⁸¹ Climate change is threatening this industry in a number of ways. For example, Douglas fir accounts for almost half the timber harvested in Washington.²⁸² Under a moderate greenhouse gas scenario, Douglas fir habitat is expected to decline 32 percent by the 2060s relative to 1961-1990.²⁸³ In addition, the area of Washington forest where tree growth is severely limited by water availability is projected to increase (relative to 1970-1999) by about 32 percent in the 2020s, with an additional 12 percent increase in the 2040s and another 12 percent increase in the 2080s.²⁸⁴ Wildland fires pose another threat to Washington's forests. Under a business as usual greenhouse gas scenario, decreases in summer precipitation, increases in summer temperatures and earlier snow melt are predicted to result in up to a 300 percent increase in the area in eastern Washington burned annually by forest fires²⁸⁵ and up to a 1000 percent increase in area burned annually on the west side of the state (typically, the wet side).²⁸⁶

By far the highest costs to the state, however, are expected to come from harm to public health. More frequent heat waves and more frequent and intense flooding may harm human health directly. Warming may also exacerbate health risks from poor air quality and allergens. Climate change can indirectly affect human health through its impacts on water supplies, wildfire risks, and the ways in which diseases are spread. Risks are often greatest for the elderly, children, those with existing chronic health conditions, individuals with greater exposure to outside conditions, and those with limited access to health resources.²⁸⁷

District of Columbia

The District of Columbia is a densely populated area located at the confluence of two tidal rivers and accordingly is particularly vulnerable to the impacts of climate change including dangerous heat waves, flooding caused by rising tides and heavy rains, and increasingly severe weather.

²⁸⁰ Washington Forest Protection Association, Sustainable Forestry, <http://www.wfpa.org/sustainable-forestry/> (last visited Oct. 24, 2018).

²⁸¹ Washington Department of Commerce, Forest Products Sector, at <http://www.commerce.wa.gov/growing-the-economy/key-sectors/forest-products/> (last visited Oct. 24, 2018).

²⁸² Washington Department of Natural Resources, 2015 Washington Timber Harvest Report, (Sept. 2016), *available at* https://www.dnr.wa.gov/publications/em_obe_wa_timber_harvest_2015_final2.pdf

²⁸³ State of Knowledge Report, *supra*, at 7-1.

²⁸⁴ *Id* at 7-3.

²⁸⁵ *Id*.

²⁸⁶ *Id* at 7-4.

²⁸⁷ State of Knowledge, Puget Sound, *supra*, at ES-7.

Water levels along the Potomac and Anacostia Rivers have increased 11 inches in the past 90 years due to a combination of sea level rise and subsidence. As a result, nuisance flooding has increased by more than 300% according to the National Oceanic and Atmospheric Administration.²⁸⁸ By 2080, the U.S. Corps of Engineers predicts up to 3.4 feet of additional sea level rise in the District.²⁸⁹ At the same time, heavy rain events are projected to grow more frequent and intense according to local climate change projections completed by the District. As a result, today's 100-year rain event could become a one in 25-year event by mid-century.²⁹⁰ The combined impact of rising tides and heavier rains pose significant threats to the District's infrastructure, community resources, cultural assets, government and military facilities, and residents. For example, during the second half of the century, Joint Base Anacostia-Bolling and Washington Navy Yard can expect more frequent and extensive tidal flooding, loss of currently utilized land, and substantial increases in the extent and severity of storm-driven flooding. With an intermediate rate of sea level rise, Naval Support Facility Anacostia could lose roughly 50 percent of its land area, and the Washington Navy Yard about 30 percent of its current land area, by end of century.²⁹¹

The District is also vulnerable to rising temperatures and a corresponding increase in extreme heat events. Local climate change projections indicate that the number of heat emergency days, defined as days when the heat index exceeds 95 degrees Fahrenheit, could more than double from the current 29 days per year to 80 days per year by the 2050s under a high emission scenario.²⁹² As temperatures rise, and dangerously hot days grow more frequent, heat-related illnesses are also likely to increase. Hotter temperatures can also stress infrastructure like roads, rail lines, and our power grid, causing disruptions.

Boulder, CO

Like many cities and communities across the country and around the world, Boulder is adjusting to a "new normal," where the effects of climate change are becoming increasingly

²⁸⁸ National Oceanic and Atmospheric Administration (2014), *Sea Level Rise and Nuisance Flood Frequency Changes around the United States*, NOAA Technical Report NOS CO-OPS 073 available at http://www.noaanews.noaa.gov/stories2014/20140728_nuisanceflooding.html.

²⁸⁹ District of Columbia Department of Energy & Environment (2015), *Climate Projections & Scenario Development*, p. 46, available at https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/150828_AREA_Research_Report_Small.pdf

²⁹⁰ *Id.* at 36.

²⁹¹ **Union of Concerned Scientists, *On the Front Lines of Rising Seas: Joint Base Anacostia-Bolling and Washington Navy Yard* (2016), available at** <https://www.ucsusa.org/global-warming/global-warming-impacts/sea-level-rise-flooding-joint-base-anacostia-bolling-and-washington-navy-yard#.WIPQVrynHRY>

²⁹² Climate Projections & Scenario Development, *supra*, at 27.

apparent. Global climate change will affect Boulder's ability to deliver services including fire protection and other emergency services, flood control and public works projects, and health care and social services for vulnerable populations.

According to the National Climatic Data Center, the frequency of billion-dollar extreme weather events from severe storms, flooding, droughts and wildfires has increased dramatically in recent years, trending from an average of less than three events per year in the 1980s to an average of nearly ten events per year from 2010 to 2014.²⁹³

The 2011 National Academies of Science assessment indicates that a one-degree Celsius rise in temperature would increase fire incidence probabilities by over 600 percent.²⁹⁴ Rising temperatures also increase the length of drought cycles, which intensify flood, fire risks and create additional risks for Boulder's water supply. These dry conditions have in turn exacerbated insect, exotic weed, and disease threats in the flora and fauna communities.

In addition, a 2015 report by the University of Colorado Boulder and Colorado State University prepared for the Colorado Energy office states that Colorado's climate has warmed in recent decades, and climate models unanimously project this warming trend will continue into the future.²⁹⁵ Although the actual pace of warming is dependent on the rate of worldwide greenhouse gas emissions, climate change has impacted and will continue to impact Colorado's resources in a variety of ways, including more rapid snowmelt, longer and more severe droughts, and longer growing seasons.

Since 1989, Boulder County has experienced four major wildland fires, the most recent of which was the Fourmile Canyon fire in 2010. The Fourmile Canyon fire destroyed over 6,000 acres of forest and 168 homes. The City's principal water treatment facility is in the region affected by the fire and was placed at risk.²⁹⁶

In September 2013, the City experienced a flood that caused damages estimated as high as \$150 million. In the region, four people died, 1,202 people were airlifted from their homes, and 345 homes were destroyed. Over a period of eight days, Boulder received an unprecedented 17.15 inches of rain. To put this into context, Boulder's annual average precipitation is just 19.14 inches. In September, Boulder normally averages just 1.61 inches of rain. This disaster was so widespread and devastating that the Boulder County Board of Commissioners declared a county-

²⁹³ National Climatic Data Center, *Extreme Weather*, <https://nca2014.globalchange.gov/report/our-changing-climate/extreme-weather> (last visited Oct. 24, 2018).

²⁹⁴ Lukas, Jeff, et al., *Climate Change in Colorado* (Aug. 2014), available at https://www.colorado.edu/climate/co2014report/Climate_Change_CO_Report_2014_FINAL.pdf

²⁹⁵ *Colorado Climate Change Vulnerability Study* (Jan. 2015), available at http://www.colorado.edu/climate/co2015vulnerability/co_vulnerability_report_2015_final.pdf

²⁹⁶ Graham, Russell, et al., *Fourmile Canyon Fire Findings* (Aug. 2012), available at https://www.fs.fed.us/rm/pubs/rmrs_gtr289.pdf

wide disaster, the Governor declared the flood a state disaster, and the President declared the flood a national disaster.²⁹⁷

Boulder's complex topography and natural climate variability make it difficult, and sometimes impossible, to predict when and how often extreme events may occur. Flash flooding, for example, does not follow the boundaries of established flood maps, a lesson learned through the adversity of the 2013 floods. Flash floods may inundate neighborhoods and roads with little advance notice, impacting locations that may not have experienced flooding in the past. At the same time, increasing global temperatures exacerbate many of these hazards.²⁹⁸

But shocks are not limited to natural hazards or the effects of climate change. A globally-connected economy and the ability for pests and diseases to circle the globe with unprecedented speed, for example, mean our community's will face a host of challenges that can strike at little notice and have severe, unknowable repercussions.

Perhaps the most significant long-term impact of climate change to Boulder is the potential for impacts to water supply. Increased temperatures will require larger amounts of water to sustain outdoor uses such as agriculture and urban tree canopies. About 89 percent of the water consumption in Colorado is associated with agriculture so even a modest increase in agricultural water needs will have a significant impact on overall water demands in the state.²⁹⁹

Like most water users in Colorado, Boulder's water supply infrastructure depends on the accumulation of snowpack in the Rocky Mountains during winter months followed by a predictable melting and runoff into storage reservoirs throughout the rest of the year. A significant shift from snow to rain or in the timing of runoff would result in a shortfall in water supply because reservoirs are not sized to hold water supply that historically was held in the snowpack.³⁰⁰

Although virtually any aspect of Boulder's economy could be affected by changes in the climate, specific industries that rely on natural resources—agriculture, tourism and recreation, and mining and extraction—are particularly vulnerable. Reduced snowpack is an obvious concern in the ski sector, but also important are earlier melt as well as seasonal shifts in temperature, which can exacerbate wildfire potential, negatively affect plants and wildlife, and increase public exposure to vector-borne diseases.³⁰¹

²⁹⁷ Boulder County, 2013 Flood Recovery, <https://www.bouldercounty.org/disasters/flood/2013-flood/> (last visited Oct. 24, 2018).

²⁹⁸ *Climate Change in Colorado*, *supra*.

²⁹⁹ *Id.*

³⁰⁰ *Id.*

³⁰¹ *Colorado Climate Change Vulnerability Study*, *supra*.

Chicago

Climate change will exacerbate existing environmental impacts on Chicago residents and lead to new, harmful impacts. Detailed, peer-reviewed federal research has exhaustively examined climate change impacts. In 2014, the US Global Change Research Program published the Third National Climate Assessment (NCA-3), developed with input from 13 federal agencies. The NCA-3 noted that climate change poses a threat to human health in many ways, including “increased extreme weather events...decreased air quality, threats to mental health, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks.”³⁰² Each of those threats is likely to exacerbate existing public health concerns affecting Chicagoans. For example, the health of the people of Chicago under current conditions already includes a substantial burden of asthma, which is worsened by decreased air quality. Mental health is also already a major concern, especially for Chicago’s substantial low income population. Waterborne, foodborne, and vectorborne disease are already costly in their tolls on the health of Chicago residents and the economy.³⁰³

Many Americans are already familiar with high-impact weather events impacting Chicago. Most tragically, Chicago has suffered from extreme weather in the form of the 1995 heat wave (which caused an estimated 741 deaths). Since 1980, Chicago’s average temperature has increased approximately 2.6 degrees.³⁰⁴ In the near future, Chicago will likely experience between 5 to 25 days a year with heat and humidity conditions similar to the 1995 heat wave that caused approximately 750 deaths in the city.³⁰⁵ In addition, urban flooding during and after intense rain storms, leads to economic losses for families and businesses. The City of Chicago and other public agencies spend significant sums to support the readiness of public health professionals, emergency response agencies, and health care delivery systems so that they are resilient to extreme weather.³⁰⁶

³⁰² U.S. Global Change Research Program, NCA-3, at 221 (2014), *available at* https://nca2014.globalchange.gov/system/files_force/downloads/low/NCA3_Full_Report_09_Human_Health_LowRes.pdf?download=1

³⁰³ See Physicians for Social Responsibility – Chicago Chapter, Cook County Climate Change and Public Health Action Plan at 7-11, *available at* <http://www.chicagopsr.org/PDFs/climatechangepublichealthplancookcounty.pdf> (discussing prevalence and impact of waterborne, foodborne and vectorborne disease in Cook County, in which Chicago is the largest municipality).

³⁰⁴ Chicago Climate Action Plan, Climate Change and Chicago, http://www.chicagoclimateaction.org/pages/climate_change_and_chicago/5.php (last visited Oct. 24, 2018).

³⁰⁵ Hettinger, Claire, *Illinois could see effects of climate change as soon as 2020* (Sept. 1, 2016), <http://cu-citizenaccess.org/2016/09/01/illinois-could-see-effects-of-climate-change-as-soon-as-2020/> (last visited Oct. 24, 2018); Hayhoe, K., et al., “Climate change, heat waves, and mortality projections for Chicago,” in *J. of Great Lakes Res.*, Vol. 36, Supp. 2, pp. 65-73 (2010), <https://doi.org/10.1016/j.jglr.2009.12.009>.

³⁰⁶ See e.g., City of Chicago, Application Narrative for Public Comment, National Disaster Resilience Competition (March 11, 2015) (discussing City and sister agency expenditures to prepare for

In 2017, the Fourth National Climate Assessment (NCA-4), “Climate Science Special Report” (CSSR), also published by the U.S. Global Change Research Program, provided updated information about the current state of the climate and the risk of extreme heat and flooding in the U.S. While data summaries or climate projections were not available solely for Chicago, information specific to the Midwest was provided and can be used to make reasonable estimates of climate impacts in the city itself. The CSSR was “designed to be an authoritative assessment of the science of climate change, with a focus on the United States, to serve as the foundation for efforts to assess climate-related risks and inform decision-making about responses.”³⁰⁷ The CSSR notes that “[t]he last few years have seen record-breaking, climate-related weather extremes, and the last three years, specifically, have been the warmest years on record for the globe. These trends are expected to continue over climate timescales.”³⁰⁸

Looking to the future, the CSSR predicts how climate change will exacerbate public health risks for Chicagoans, especially urban heat waves and urban flooding. “Heatwaves have become more frequent in the United States since the 1960s, while extreme cold temperatures and cold waves are less frequent. Recent record-setting hot years are projected to become common in the near future for the United States, as annual average temperatures continue to rise. Annual average temperature over the contiguous United States has increased by 1.8°F (1.0°C) for the period 1901–2016; over the next few decades (2021–2050), annual average temperatures are expected to rise by about 2.5°F for the United States, relative to the recent past (average from 1976–2005), under all plausible future climate scenarios.”³⁰⁹ The CSSR also notes that annual precipitation has increased in Midwest, and with “high confidence” that “[h]eavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901.”³¹⁰ Particularly concerning is that “[t]he frequency and intensity of heavy precipitation events are projected to continue to increase over the 21st century.”³¹¹

The CSSR, marshalling scientific expertise from across the federal government, makes it clear that locations in the Midwest such as Chicago are expected to face increases in extreme weather events (as summarized above). Given the sound scientific basis for an expected increase in heat-related and flood-related health problems in the Chicago area, action at all levels of government is needed to prepare for those problems.

and react to extreme weather events), *available at*

https://www.cityofchicago.org/content/dam/city/progs/env/2015_03_11_Chicago_NDRC_Consolidated-PUBLICDRAFT.pdf.

³⁰⁷ USGCRP, 2017: *Climate Science Special Report: Fourth National Climate Assessment* at 1, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)], *available at* https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf.

³⁰⁸ *Id.* at 12.

³⁰⁹ *Id.* at 11.

³¹⁰ *Id.* at 20.

³¹¹ *Id.* at 207.

While the City of Chicago is investing in climate change adaptation and resilience measures, it is essential that the federal government does all it can to reverse the causes of the abrupt warming of the Earth: the well-documented increase in concentrations of heat-trapping gases in the atmosphere. The costs of the Clean Power Plan are likely dwarfed by the massive savings in health care expenditures for heat-related illness, flood-related illness, and other health conditions, as well as the economic damages due to flooding in cities like Chicago. Any consideration of rescinding the Clean Power Plan and replacing it with a weaker rule such as EPA's ACE proposal must include the health and economic impacts of the anticipated increase in heat waves and flooding in Chicago.

The City of Los Angeles

As EPA's August 2016 bulletin entitled "What Climate Change Means for California" recognized, California's climate is changing, and Southern California in particular has already warmed about three degrees (F) in the last century.³¹² Like California as a whole, in Los Angeles, climate change will result in more common heat waves, less rainfall, increased stress on water supplies, increased risk of wildfires, and increased threats to coastal development and infrastructure.

As for heat waves, a recent UCLA study concluded that under a business as usual scenario, the annual number of days when temperatures exceed 95 degrees (F) in Los Angeles will increase from 6 days (1981-2000) to 22 days (2041-2060), and ultimately to 54 days (2081-2100).³¹³ EPA's August 2016 bulletin recognizes that hot days "can be unhealthy—even dangerous." Indeed, high air temperatures, which are amplified in urban settings like Los Angeles, can cause heat stroke and dehydration and affect people's cardiovascular, respiratory, and nervous systems. Furthermore, as EPA's bulletin recognizes, warming can also increase the formation of ground-level ozone, a component of smog that can contribute to respiratory problems. Los Angeles already has the worst smog in the nation, and as the climate changes, progress toward clean air will become even more difficult and expensive. Extreme heat and poor air quality not only negatively impact Los Angeles residents and City employees, but also the City's ability to retain Los Angeles's status as a desirable business and tourist destination.

EPA's bulletin also recognized that the changing climate "is likely to increase the need for water but reduce the supply."³¹⁴ Studies cited in the Los Angeles Department of Water and Power (LADWP) 2015 Urban Water Management Plan reach the same conclusion. On the demand side, forecasted warming is projected to result in as much as a 7 percent increase in

³¹² See EPA, *What Climate Change Means for California* (Aug. 2016), available at <https://www.epa.gov/sites/production/files/2016-09/documents/climate-change-ca.pdf>.

³¹³ See *The Climate Change in the Los Angeles Region Project*, http://research.atmos.ucla.edu/csrl/LA_project_summary.html (last visited Oct. 24, 2018).

³¹⁴ EPA, *What Climate Change Means for California*, *supra*.

water demand.³¹⁵ Additionally, climate change would put stress on existing water supply infrastructure. The Los Angeles Aqueduct (LAA), which is one of the major imported water sources delivering a reliable water supply to the City, serves as just one example. The LAA originates approximately 340 miles away from Los Angeles, gathering snowmelt runoff in the Eastern Sierra Nevada. Projected changes in temperature (warmer winters) are anticipated to change precipitation patterns in the Eastern Sierra Nevada with less snow and more rain than historically encountered. This could strain the LAA's capacity to store runoff in surface reservoirs, as runoff would come earlier in the season than if the snowpack gradually melted in spring and summer, as has historically been the case. If climate change occurs as predicted, the City may have to expend substantial resources for operational and infrastructure changes to the LAA to ensure Los Angeles' continued reliance on this water source.³¹⁶

EPA's bulletin also recognizes that "higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires," which already pose a substantial problem in Los Angeles. Indeed, 2017 was one of the worst wild fire seasons on record. As of December 12, 2017, it was reported that more than 405 square miles in Southern California had burned, 1160 structures had been destroyed, 90,000 people had been displaced, and more than 10,000 fire fighters from California ten other states had been employed to save lives and homes.³¹⁷ Researchers project that fires driven by Santa Ana winds, and the fires that occur earlier in the year in Southern California, will burn larger areas by midcentury in part due to rising temperatures.

Finally, the City of Los Angeles has substantial public and private coastal development. Sea level rise caused by climate change may threaten both private property and public infrastructure along the Los Angeles coast, including at the Port of Los Angeles, which ranks as the #1 container port in the United States and North America.

New York City

Changing climate hazards in the New York metropolitan region are increasing the risks for the people, economy, and infrastructure of New York City in numerous and dramatic ways, as documented in the New York City Panel on Climate Change's January 2015 report, *Building the Knowledge Base for Climate Resiliency*.³¹⁸ Annual temperatures are hotter, heavy downpours

³¹⁵ LADWP 2015 Urban Water Management Plan, Chapter 12, at 5 (2015), *available at* https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-sourcesofsupply/a-w-sos-uwmp?_adf.ctrl-state=ty6h0ptsh_29&_afLoop=280191713614151

³¹⁶ *Id.* at 6-9.

³¹⁷ See Fonseca, Ryan, *The Thomas fire and Southern California's other major wildfires by the numbers*, Los Angeles Daily News (Dec. 7, 2017; updated Dec. 12, 2017), *available at* <https://www.dailynews.com/2017/12/07/by-the-numbers-the-southern-california-wildfire-battles-in-la-ventura-counties/>.

³¹⁸ New York City Panel on Climate Change, *Building the Knowledge Base for Climate Resiliency: New York City Panel on Climate Change 2015 Report*, Annals of the New York Academy of Science, Vol. 1336 (Jan. 2015), at 9, *available at*

are increasingly frequent, and the sea is rising. These trends are projected to continue and even worsen in the coming decades due to higher concentrations of greenhouse gases in the atmosphere.

Sea level rise in New York City has averaged 1.2 inches per decade since 1900, nearly twice the observed global rate, with a total increase of more than a foot; approximately 60 percent of that rise is driven by climate-related factors.³¹⁹ As discussed above in the New York State section, this increase in sea level exacerbated the destruction of homes and businesses from flooding during Hurricane Sandy.³²⁰

Climate change also risks New Yorkers' health and safety. Extreme weather events can result in injury and loss of life resulting from exposure, interrupted utility service, or lack of access to emergency services.³²¹ In addition, warming temperatures exacerbate or introduce a wide range of health problems, including cardiovascular and respiratory diseases, pollution and allergen-related health problems, and vector-borne diseases.³²² The health consequences of climate change disproportionately affect our most vulnerable populations – the elderly, children, and low-income communities who already experience elevated instances of cardiovascular and respiratory diseases.³²³

Long-term changes in climate mean that when extreme weather events strike, they are likely to be increasingly severe and damaging. By the 2050s, New York City will likely experience sea levels that are up to thirty inches higher than today, the number of days with rainfall at or above two inches is projected to increase by as much as 67% by the 2020s, and by the 2080s, what would today be considered a 100-year flood (*i.e.*, a flood that has a 1% chance of occurring in any given year) could have as high as a 12% chance of occurring in any given year, and this flooding could be as much as 4.8 feet higher than today's 100-year flood because of sea level rise.³²⁴ New York City is also likely to experience more frequent heavy downpours and many more days at or above 90 degrees Fahrenheit by that timeframe.³²⁵

Rising sea levels will expose the homes, businesses, streets, wastewater treatment plants, and power plants that line our 520 miles of coastline to increased hazards. More extreme weather

<http://onlinelibrary.wiley.com/doi/10.1111/nyas.2015.1336.issue-1/issuetoc> (hereinafter “*New York City Panel on Climate Change 2015 Report*”).

³¹⁹ *New York City Panel on Climate Change 2015 Report, supra*, Chapter 2.

³²⁰ *Id.*

³²¹ *Id.* at 70.

³²² *Id.* at 78-82.

³²³ See DOHMH, *Air Pollution and the Health of New Yorkers: The Impact of Fine Particles and Ozone* at 4, at <https://www1.nyc.gov/assets/doh/downloads/pdf/eode/eode-air-quality-impact.pdf>; see also Globalchange.gov, *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* Ch. 9, *Populations of Concern* (April 2016), at <https://health2016.globalchange.gov/populations-concern>.

³²⁴ *New York City Panel on Climate Change 2015 Report, supra*, at 31-33, 40-42.

³²⁵ *Id.* at 27.

will also leave the City and its essential infrastructure susceptible to more frequent violent storms and severe flooding; at other times, the new extremes could subject the City to prolonged periods of drought.³²⁶

Heat waves, defined as three or more consecutive days of temperatures at or above 90 degrees, strain the City's power grid, cause deaths from heat stroke, and exacerbate chronic health conditions, particularly for vulnerable populations like the elderly.³²⁷ Without mitigation of greenhouse gas emissions, the City can expect temperatures at or above 90°F for thirty-three days per year by the 2020s, for fifty-seven days by the 2050s, and for eighty-seven days by the 2080s.³²⁸

Philadelphia

Since 2010, Philadelphia has experienced a variety of extreme weather, including the snowiest winter, the two warmest summers, the wettest day, and the two wettest years on record, as well as two hurricanes and a derecho (a severe windstorm—usually associated with thunderstorms—that produces damage along a relatively straight path). Fifty-seven daily high temperature records have been set in Philadelphia since the year 2000, 28 of them since the year 2010. And the sea level around Philadelphia has been rising at a rate of roughly 0.11 inches per year since 1900, equivalent to an increase of nearly one foot in 100 years.³²⁹

Scientists expect these trends to continue in the future, at an accelerating pace and with increasing severity. The best available climate information suggests that weather in Philadelphia will become warmer and wetter during all seasons in the years and decades ahead, and that the rate of sea level rise will increase, especially toward the end of this century.³³⁰

Changes in climate matter to Philadelphia. Storms, heat waves, and floods already pose risks to residents and infrastructure, and the city is responsible for responding to these events by plowing the streets, managing stormwater, keeping Philadelphians safe during storms, and

³²⁶ See generally *id.* at 23-27. For a comprehensive discussion of the likely effects of climate change on New York City's watershed and water delivery systems, see New York City Department of Environmental Protection Climate Change Program, *Assessment and Action Plan* (May 2008), at http://www.nyc.gov/html/dep/pdf/climate/climate_complete.pdf. Details of climate change impacts on the City's wastewater treatment system are presented in DEP's *NYC Wastewater Resiliency Plan: Climate Risk Assessment and Adaptation Study* (Oct. 2013), at http://www.nyc.gov/html/dep/html/about_dep/wastewater_resiliency_plan.shtml.

³²⁷ *New York City Panel on Climate Change 2015 Report*, *supra*, at 26.

³²⁸ *York City Panel on Climate Change 2015 Report* at 31.

³²⁹ Mayor's Office of Sustainability & ICF International, *Growing Stronger: Toward A Climate-Ready Philadelphia*, at 5 (2015), available at, <https://beta.phila.gov/media/20160504162056/Growing-Stronger-Toward-a-Climate-Ready-Philadelphia.pdf>

³³⁰ *Id.*; see also ICF Incorporated, L.L.C., *Useful Climate Information for Philadelphia*, at 3 (2014), available at <https://beta.phila.gov/media/20160505145605/Useful-Climate-Science-for-Philadelphia.pdf>.

leading cleanup efforts when the storms clear. Philadelphia needs to build resilience to accommodate today's extremes while accounting for expected changes in the frequency of these events in the future.³³¹

Expected effects of climate change in Philadelphia fall into three broad categories:

- *New Normals*

The city's buildings and infrastructure were designed to withstand past climate conditions, not those that scientists expect will occur in the future. Over time, prolonged exposure to higher temperatures and changing precipitation patterns may lead to safety hazards, service outages, and higher maintenance costs.

- *Changing Extremes*

Extreme events such as heat waves, intense rain or snowstorms, and tropical storms and hurricanes are expected to become more frequent and/or more severe as the climate changes.

- *Rising Seas*

Although Philadelphia is 90 miles inland from the mouth of the Delaware Bay, higher sea levels will raise water levels in the Delaware and Schuylkill Rivers. Higher baseline river levels would not only permanently inundate parts of Philadelphia but also increase the depth and extent of flooding in and around the city from storm surges.³³²

The impacts of climate change in Philadelphia will be costly. Just one severe hurricane could cause more than \$2 billion in damages citywide.³³³ On top of these additional disaster costs, climate change will increase the everyday cost of doing business.³³⁴

Extreme heat is also likely to increase risks to the health of vulnerable populations in the city. Heat events and hot days are projected to increase substantially in Philadelphia by the end of this century. Populations that are potentially vulnerable to extreme heat include the elderly, the very young, people with low socioeconomic status, and people without access to air-conditioned spaces. Nearly 27 percent of Philadelphia's population lives under the poverty level, more than 12 percent of the population is aged 65 years or older, and seven percent is under five years old.³³⁵

Heat can have both direct physiological impacts on health (such as heat stroke) and indirect impacts: for example, hot weather encourages the formation of ground-level ozone, which reduces air quality and poses risks to individuals with respiratory conditions such as

³³¹ See Growing Stronger: Toward A Climate-Ready Philadelphia, *supra*, at 5

³³² *Id.*

³³³ *Id.* at 9

³³⁴ *Id.*

³³⁵ *Id.* at 13

asthma. In 2010, nearly a quarter of children in Philadelphia County had asthma, among the highest rates in the nation.³³⁶

Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined, killing an average of 50 people per year between 1997 and 2004. A 10-day heat wave that hit Philadelphia in July 1993 resulted in 118 deaths.³³⁷

Extreme heat can also affect city services and infrastructure. For example, interviews with city departments indicated that hotter days may require construction activities (including street paving and repairs) to shift to night hours, and pavement may require longer curing times. Extreme heat that persists for multiple days and nighttime temperatures that remain elevated magnify these impacts.³³⁸

Rising sea levels are expected to increase the frequency and severity of flooding in Philadelphia. Coastal storms combined with higher sea levels will cause more extensive flooding than the same storms would cause today, although tides, saturation of the ground, ground temperature, and other factors can vary the degree of flooding experienced from two storms with the same amount of rainfall.³³⁹

Flooding presents many risks to Philadelphia, including public health and safety hazards, interruptions in key services, and damage to buildings and infrastructure. Floods can disrupt transportation, hampering emergency services and evacuation efforts. Because fuel pumps and sump pumps require electricity to operate, a power failure during a flood could limit the availability of fuel for generators and vehicles, and allow water levels to rise in buildings and other facilities.³⁴⁰

South Miami, FL

The City of South Miami is situated atop the Miami Ridge, a limestone outcropping that is cut through by a series of transverse glades that drain the Everglades basin into Biscayne Bay. The southernmost edge of the City of South Miami borders one such glade, the Snapper Creek Canal. South Miami is bisected by a second transverse glade, the Ludlam Glades Canal, which empties into the Snapper Creek Canal. In 2009, FEMA designated neighborhoods in these transverse glades as flood zone AE, requiring flood insurance.

By the late 1960s, saltwater had intruded far up the coastal drainages of Miami-Dade County. A series of saltwater exclusion dams were constructed on the canals and creeks to limit upstream flow, including on the Snapper Creek Canal downstream of South Miami. These dams freshened the drainages, but saltwater continued to advance underground because local sea level

³³⁶ *Id.*

³³⁷ *Id.*

³³⁸ *Id.*

³³⁹ *Id.* at 14

³⁴⁰ *Id.*

rise increased the hydrostatic pressure of intruding saltwater. As of 2011, underground saltwater had reached the southeastern corner of the City of South Miami. The South Florida Water Management District increased the height of the freshwater head on the inland side of the saltwater dams to counter the underground intrusion of saltwater. The maximum height of the freshwater buildup, however, has been limited by the low-elevation of the western suburbs, which, by law, cannot be deliberately flooded.

Local sea level rise in South Florida, including the City of South Miami, has greatly exceeded global sea level rise. Since 2010, Miami has seen an extra 5” of sea level rise. With the increase in local sea level rise in Miami, saltwater has begun overtopping the Snapper Creek Canal exclusion dam during recent “king tides” in October and November.³⁴¹

Local sea level rise has increased the distance that storm surge can penetrate inland. Two days before landfall of Hurricane Irma on September 9, 2017, the National Hurricane Center issued its first ever storm surge warning for South Miami. For the first time ever, Miami-Dade County responded to the flood warning with a mandatory evacuation order for most of the City of South Miami.³⁴² Even though the storm center diverted, low areas of the City experienced floodwaters, and adjacent areas closer to the bay experienced significant damage from storm surge and flooding.

An unseen side-effect of the underwater battle being waged between freshwater and saltwater has been the rise of the local water table. In 2015, GEI Consultants, Inc. identified septic systems as the infrastructure in the City of South Miami at most immediate risk from the rising water table: “*The Snapper Creek Study Area had 11 properties (or 73% of the 15 records available) that were estimated to have the bottom of drainfield reached by rising groundwater within the next 25 years.*” When groundwater reaches the level of a house’s septic drainfield, wastewater from the house (including the toilets) will backflow into the bathtub instead of the septic tank. The remedy is replacing septic systems with a municipal sewer system.³⁴³

The City of South Miami, on September 15, 2015, approved a resolution authorizing SRS Engineering Inc. to provide complete engineering documents consistent with a Citywide Sanitary Sewer Master Plan to replace the vulnerable septic systems with municipal sewer infrastructure. The master plan was completed on September 14, 2016 with a total estimated cost to the City and its residents of \$47,639,833.26.³⁴⁴

³⁴¹ Dessu SB, Price RM, Troxler TG, Kominoski JS (2018). Effects of sea-level rise and freshwater management on long-term water levels and water quality in the Florida Coastal Everglades. *Journal of Environmental Management*, 21, 164-176, *available at* <https://doi.org/10.1016/j.jenvman.2018.01.025>

³⁴² *Miami-Dade Expands Evacuation Order*. Miami Herald (Sept. 7, 2017).

³⁴³ Cooper JA, Loomis GW, Amador JA (2016). Hell and high water: Diminished septic system performance in coastal regions due to climate change. *PLoS One*. 2016; 11(9): e0162104. 2016 Sep 1. doi: 10.1371/journal.pone.0162104; Ariza M (Jun 25 2017) Miami, sea level rise is coming for your poop. *New Tropic*. <https://thenewtropic.com/climate-change-septic-tanks-miami/>

³⁴⁴ SRS Engineering Inc. Citywide Sanitary Sewer Master Plan, September 14, 2016.

In addition to the direct effects of sea level rise, which will compromise the City's existing sanitary waste infrastructure, the City will likely experience indirect harm based on economic factors relating to rising flood insurance costs and loss of 30-year mortgage issuance in low-lying areas. FEMA flood insurance rates have already begun to rise for the many properties in the City's AE flood zones. Based on FEMA and NOAA projections for sea level rise, indirect harm to property values will begin to manifest in the City over the next 30 years, and, as a result, the City's tax base and our ability to deliver services will become increasingly compromised.³⁴⁵

Broward County, FL

Southeast Florida is particularly vulnerable to the predicted effects of climate change due to its extensive coastline, flat landscape, porous geology, and burgeoning coastal development. In South Florida, Miami-Dade, Broward, and Palm Beach counties collectively have populations approaching 6 million residents. Millions of these residents live on or near the shoreline.³⁴⁶ Their safety depends on thousands of miles of canals for drainage and flood control.

Extreme high tides have become increasingly frequent and dramatic due to rising sea levels, over-topping seawalls, pushing up through storm water systems and contributing to flooding in communities far from the waterfront and coastal canals. King tides during the last two years have been more severe and expansive than predicted, compounded by diverse meteorological conditions, and, in 2015, occurred monthly for a full six months. These conditions revealed the complexity of the challenge, as Broward County cannot simply plan for any single scenario, but must consider the array of conditions on top of sea level rise that compound coastal flood conditions (e.g., high tides, slowing gulf stream, offshore storms, and super moons), independent of local rainfall. In Broward County, the condition is complicated by the expansive network of finger canals and waterways that generate more than 300 miles of shoreline and provide numerous entry points for water, creating vulnerabilities more expansive than the County's 23 miles of beach would suggest.³⁴⁷

Regionally, it has been estimated that \$3 billion in property value is at risk with one foot of sea level rise. A storm surge could magnify this figure significantly. Rising sea levels threaten evacuation routes and critical energy, water, and wastewater infrastructure. Fort Lauderdale recently estimated that upgrades to the city's storm water system to combat rising sea levels would reach costs of \$1 billion. In eastern Broward County, \$5 billion of property is at risk with 2 feet of sea level rise, 64 percent of which is commercial.³⁴⁸

³⁴⁵ Flavelle C (19 Apr 2017) The Nightmare Scenario for Florida's Homeowners. Bloomberg News. <https://www.bloomberg.com/news/features/2017-04-19/the-nightmare-scenario-for-florida-s-coastal-homeowners>

³⁴⁶ Coastal county definition, NOAA Office for Coastal Management, coast.noaa.gov, November 2017

³⁴⁷ Broward County, Geographic Information Systems, staff analysis

³⁴⁸ Analysis of the vulnerability of Southeast Florida to Sea Level Rise. August 2012. Southeast Florida Regional Climate Change Compact Inundation Mapping and Vulnerability Assessment Work Group, August 2012

Despite its severity, coastal flooding represents just a sliver of the challenge. The broader Broward landscape is also at risk due to the influence of sea level rise on our complex drainage and flood management system, as well as the groundwater table. Already, groundwater monitoring wells reveal a one-foot increase in groundwater elevations in coastal areas of the County, a condition that degrades the function of drainage wells and water management systems designed in accordance of hydrologic conditions that no longer exist. Hydrologic modeling performed in partnership with the U.S. Geological Survey (USGS) reveals a predicted one-to-one relationship between sea level rise and change in groundwater table in coastal areas of the county with 2.5 feet of sea level rise. The influence on the groundwater table is expected to reach more than 6 miles inland with a 50% response to each foot of sea level rise. This loss of groundwater storage is already compounding flooding, and will contribute to flood stages and flood risk for a growing portion of the community.³⁴⁹

For western communities, flood protection relies upon the ability of canals to drain stormwater runoff via discharge to the coast, discharge which is made feasible by gravity. Control gates separate tidal and freshwater reaches of these canals, but as rain falls and water stages increase, the gates are opened for flood relief, allowing inland stormwater to flow down gradient and discharge to tide. As sea level has risen, the downstream gradient has diminished, and discharges are slowed. During extreme high tide, some gates must remain closed, as coastal water levels rise above canal stages preventing release of stormwater and aggravating flood risk. Pumps to replace these gravity water control structures are estimated to cost \$50 million each.³⁵⁰ Existing pump systems are also inadequate. Provisional modeling performed by the USGS indicates that, by 2060, increases in groundwater level in response to rising seas will require an existing pump to run 24 hours a day to maintain flood control elevations.³⁵¹

Rising seas impact water supplies as well, driving saltwater contamination into wellfields. USGS modeling in collaboration with the County reveals the predicted loss of 35 million gallons per day (MGD) in water supply capacity by 2060 (40 percent of Broward's coastal wellfield capacity), due fully to the additional influence of sea level rise. Sea level rise has doubled the rate of local saltwater intrusion into coastal wellfield (as compared to the influences of regional water management) and water supply operations. While the impacts will be realized county-wide, the affected wellfields pertain to Broward County and the Cities of Deerfield Beach, Pompano Beach, Hollywood, Dania Beach, and Hallandale Beach. The County is currently collaborating in a multi-jurisdictional alternative water supply project to help mitigate for these losses with construction of a 35 MGD surface water reservoir. The Phase 1 project cost is \$161 Million.

³⁴⁹ Groundwater monitoring well data is available via <https://nwis.waterdata.usgs.gov/nwis/gwlevels>. Hydrologic modeling performed by the USGS and site-specific engineering calculations reveal recent and predicted loss of storage and compounded flood risk. Model results are not yet published.

³⁵⁰ This is a minimum cost estimate based on FEMA reimbursement for retrofit of an equivalent structure in Miami-Dade County.

³⁵¹ Results not yet published.

In response to these overarching risks, Broward County, partner counties in the Southeast Florida Regional Climate Change Compact (Compact), and more than half of Broward municipalities have adopted a regional sea level rise projection for planning purposes, with an estimated 11 to 23 inches of additional sea level rise predicted by 2060.³⁵² This projection was developed via the activities of the 4-County Compact, formed in early 2010 as a voluntary collaboration among Palm Beach, Broward, Miami-Dade and Monroe Counties to jointly address shared climate mitigation and adaptation challenges. The County partnered with the U.S. Army Corps of Engineers under the Planning Assistance for States Program to undertake a hydrodynamic study to evaluate the combined influence of sea level rise, high tides, and high frequency storm events on flood conditions. The results of this study substantiate proposed establishment of a regional seawall and top-of-bank standard for tidally-influenced waterways, to improve community resilience to sea level rise and coastal flooding. A third-party risk-based economic analysis associated with this study revealed a 20.5-fold increase in economic exposure with just 1 foot of sea level rise for a storm surge event with a 1% annual probability.

To address these exposures, the County has modernized regulatory standards for surface water management systems to include wet season groundwater elevations under future sea level conditions, and is undertaking remap of the 100-year flood condition with an additional two feet of sea level rise to support new standards for finished floor elevations. The implications for planning and infrastructure design will be significant, but necessary given the risk and financial exposure of inaction.³⁵³

³⁵² Unified Sea Level Rise Projection for Southeast Florida, Southeast Florida Regional Climate Change Compact. 2015

³⁵³ National Hazard Mitigation Saves: an Independent Study to Assess the Future savings from Mitigation Activities. Vol. 1 – Findings, Conclusions and Recommendations. Vol. 2-Study Documentation. Appendices. MMC (Multihazard Mitigation Council). National Institute of Building Sciences, Washington, D.C. 2005

Appendix B

Carbon Sequestration in State Statutes and Regulations

Comments of the Attorneys General of California, Connecticut, Delaware, Illinois, Iowa, Maine, Maryland, Massachusetts, Minnesota (by and through its Minnesota Pollution Control Agency), New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, and Washington, and the District of Columbia, the Maryland Department of the Environment, and the cities of Boulder (CO), Chicago, Los Angeles, New York, Philadelphia, and South Miami (FL), and Broward County (FL)

on

the Environmental Protection Agency's Proposed Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 83 Fed. Reg. 65,424 (Dec. 20, 2018)

Docket ID No. EPA-HQ-OAR-2013-0495

March 18, 2019

Carbon Sequestration in State Statutes and Regulations

STATUTES & REGULATIONS BY STATE

1. Alabama

- a. Ala. Admin Code r. 335-6-8-.01 et seq. (2011) (amended 2015): Regulations for permitting, operating, and monitoring underground injection wells, including wells for permanent storage of carbon dioxide.

2. California

- b. Cal. Code Regs. tit. 17, § 95486 (2010) (amended 2019): California's Low Carbon Fuel Standard incorporates credits for carbon capture and storage implemented in the fuel refinement process in determining a fuel's carbon intensity.
- c. Cal. Code Regs. tit. 17, § 95852(g) (2012) (amended 2015): Carbon dioxide suppliers are regulated under California's cap-and-trade program, but any carbon dioxide supplied that is ultimately geologically sequestered is not included in their compliance obligation (e.g., carbon dioxide supplied for enhanced oil recovery).
- d. Cal. Code Regs. tit. 20, § 2904 (2007): Carbon dioxide that is sequestered is not included in the CO₂ emissions compliance obligation for power plants.

3. Colorado

- a. Colo. Rev. Stat. § 40-2-123 (West 2006) (amended 2017): Provides framework for utility applications to build integrated gasification combined cycle plants with carbon capture capabilities and allows waiver of utility commission's "rules requiring competitive resource acquisition" upon proper demonstration by utility. § 40-2-123(2)(f) allows full cost recovery from ratepayers for IGCC plants with carbon capture.
- b. Colo. Rev. Stat. § 25-1-1303 (West 2006): In 2006, provided \$50,000 grant to the Colorado School of Mines to research "geologic carbon sequestration as technique for mitigating the emissions of greenhouse gases in the state."

4. Florida

- a. Fla. Stat. § 366.8255 (West 2008) (amended 2012): Allows inclusion of "[c]osts or expenses prudently incurred for scientific research and geological assessments of carbon capture and storage" in utilities' environmental compliance costs which may be recovered from ratepayers.

- b. Fla. Stat. § 366.91 (West 2008) (amended 2010): Includes “electrical energy produced using pipeline-quality synthetic gas produced from waste petroleum coke with carbon capture and sequestration” in definition of “renewable energy” and requires utilities to offer to purchase renewable energy.

5. Illinois

- a. 20 Ill. Comp. Stat. Ann. 3855/1-75 (West 2009) (amended 2018): Requires a 5% clean coal portfolio standard for utilities and sets parameters for “initial clean coal plants” that include at least 50% carbon capture and sequestration.
- b. 415 Ill. Comp. Stat. Ann. 5/13.7 (West 2011): Allows for inspection of carbon sequestration sites by IL EPA for water quality control purposes.
- c. 20 Ill. Comp. Stat. Ann. 3855/1-80 (West 2007) (amended 2016): Authorizes Illinois Power Agency to “develop, finance, construct, or operate” clean coal power plants and carbon sequestration facilities using Agency bonds.
- d. 415 Ill. Comp. Stat. Ann. 5/9.10 (West 2001): Includes carbon sequestration as potential method for generation of voluntary emissions reduction credits.
- e. 220 Ill. Comp. Stat. Ann. 5/16-115 (West 2009) (amended 2015): In order to supply electricity to alternative retail electric suppliers as part of their renewable energy portfolios, clean coal facilities must either sequester 50% of CO₂ emissions or purchase offsets to cover any drop of the total emissions sequestered below 50%.
- f. 220 Ill. Comp. Stat. Ann. § 75/1 et seq. (West 2011): “Carbon Dioxide Transportation and Sequestration Act.” Regulates the construction of pipelines to transport carbon dioxide to sequestration and enhanced oil recovery, as “critical to the promotion and use of Illinois coal.”
- g. 20 Ill. Comp. Stat. Ann. § 687/6-5 (West 2007) (amended 2019): Provides funds from a ratepayer “Renewable Energy Resources and Coal Technology Development Assistance Charge” for capturing and sequestering CO₂ from coal combustion, and supporting research on CCS technology.
- h. 20 Ill. Comp. Stat. Ann. § 3501/825-65 (West 2010) (amended 2018): Authorizes state bonds to fund construction of clean coal plants using CCS.
- i. Ill. Admin Code tit. 35, § 730, subpart H (2012) (amended 2018): Establishes criteria and standards for Class VI CO₂ geologic sequestration injection wells.
- j. Ill. Admin. Code tit. 83, Part 455 (2017): Prescribes standards for complying with renewable energy portfolio standard, including clean coal standard of 50% sequestration.

- k. Ill. Admin. Code tit. 83, 302.40 (2013) (amended 2014): Regulates the negotiation of easements by pipeline companies for development of a CO₂ pipeline from clean coal facilities to sequestration.

6. Indiana

- a. Ind. Code § 8-1-8.8-12 (West 2011): “Utility Generation and Clean Coal Technology” subsection of Utilities and Transportation Code. The subsection provides financial incentives for utilities building ‘new energy’ generators, including CCS coal plants.
- b. Ind. Code § 14-39-1-1 *et seq.* (West 2011): “Eminent Domain for Transportation of Carbon Dioxide by Pipeline” grants certified CO₂ pipeline company authority to condemn a right-of-way for construction of pipelines to transport CO₂ to EOR, deep saline injection, or sequestration, inside or outside Indiana.

7. Iowa

- a. Iowa Code Ann. § 476.53 (West 2010) (amended 2018): Includes addition of carbon capture facility as significant alteration whose costs can be recovered from ratepayers.
- b. Iowa Admin. Code r. 261-401.6 (2011): Makes energy projects implementing carbon capture and storage eligible for financial assistance.

8. Kansas

- a. Kan. Stat. Ann. § 55-1637 (West 2007) (amended 2010): “Carbon Dioxide Reduction Act.” Authorizes regulations prescribing criteria and standards for carbon dioxide injection wells.
- b. Kan. Stat. Ann. § 79-233 (West 2007): Exempts “any carbon dioxide capture, sequestration or utilization property,” including equipment, injection wells, and electric generation units with 100% carbon capture, from property taxes.
- c. Kan. Stat. Ann. § 79-32,256 (West 2007): Provides tax deduction for CCS equipment.

9. Kentucky

- a. Ky. Rev. Stat. Ann. § 353.800 *et seq.* (West 2011): The “Geologic Storage of Carbon Dioxide” subsection of the Mines and Minerals Code states an explicit “economic priority” to attract CCS projects “that will create jobs ... and favorably position the Commonwealth for future leadership and growth in the field.” Other provisions relate to rights to ownership of pore space where carbon dioxide could be stored in geologic formations and monitoring requirements for sites where carbon dioxide has been stored.

- b. Ky. Rev. Stat. Ann. § 154.27-010 et seq. (West 2007) (amended 2011): “Incentives for Energy Independence Act.” Provides incentives, including income and sales tax credits up to 100%, for carbon capture-ready projects, defined as those built with “planning for or anticipating capture of carbon dioxide in a manner to facilitate continued operation of the facility in compliance with applicable federal requirements”; *see also* Ky. Rev. Stat. Ann. § 143.31-010 et seq. (2018) (providing tax incentives for, among other projects, a CO₂ pipeline).
- c. Ky. Rev. Stat. Ann. § 154.31-020 (West 2018): Makes CO₂ transmission pipeline companies eligible for sales and use tax incentives under the Kentucky Investment Act.

10. Louisiana

- a. La. Rev. Stat. Ann. § 30:1101 et seq. (West 2009): “Louisiana Geologic Sequestration of Carbon Dioxide Act.” Section 1102 states that “[t]he geologic storage of carbon dioxide will benefit the citizens of the state and the state's environment by reducing greenhouse gas emissions.” Authorizes Commissioner of Conservation to regulate carbon storage through rules and regulations and provides various directions for the Commissioner. Releases operators from liability after completion of CO₂ injection operations.
- b. La. Rev. Stat. Ann. § 30:209 (West 2008) (amended 2009): Authorizes State Mineral and Energy Board, among other powers, to “enter into operating agreements whereby the state receives a share of revenues from the storage of oil, natural gas, liquid or liquefied hydrocarbons, or carbon dioxide.” Includes as an example “[e]stablishing a contractual agreement for the operation of a carbon dioxide storage facility for the storage and distribution of carbon dioxide for secondary or tertiary recovery operations.”
- c. La. Rev. Stat. Ann. § 30:4 (West 2007): Authorizes Department of Conservation to regulation construction, design, and operation of pipelines transmitting CO₂ to EOR projects.
- d. La. Rev. Stat. Ann. § 633.4 (West 2009): Provides a 50% tax reduction on EOR projects that use anthropogenic carbon dioxide.
- e. La. Admin Code tit. 43, pt. XIX, § 403 (2016): Regulates the injection of CO₂ for EOR operations, including provisions to prevent or correct CO₂ leaks.
- f. La. Admin Code tit. 43, pt. XI, subpt. 4 (amended 2017): Regulates construction, design, and operation of CO₂ transmission pipelines, including detailed regulations on safety and maintenance.

11. Maine

- a. Me. Rev. Stat. tit. 38. § 585-K (West 2008): Subsection 4 provides that carbon dioxide that has been “captured and used for a commercial purpose” or “permanently disposed of in geological formations” shall not be counted as emissions for the purpose of the code.

12. Massachusetts

- a. Mass. Gen. Laws Ann. ch. 23J § 1 (West 2008) (amended 2009): Carbon capture and sequestration is included in the definition of “clean energy research” that may be supported by Massachusetts Alternative and Clean Energy Investment Trust Fund.

13. Michigan

- a. Mich. Comp. L. Ann. § 205.303 (West 2014): Grants a reduced severance tax rate to approved EOR projects using carbon dioxide injection.
- b. Mich. Comp. L. Ann. § 460.1047 (West 2017): Allows power plants to recover costs of constructing and maintaining “advanced cleaner energy systems,” which include, in coal-fired plants, carbon capture and geologic sequestration of 85% or more CO₂ emissions.
- c. Mich. Comp. L. Ann. § 483.3 (West 2014): Authorizes Public Service Commission to regulate CO₂ transmission pipelines.
- d. Mich. Admin. Code. r. 299.9204 (2016): Regulates CO₂ pipelines and injection wells as Class VI injection wells.

14. Minnesota

- a. Minn. Stat. Ann. § 116J.437 (West 2008) (amended 2013): “Carbon capture, storage, or sequestration” is included in definition of “green economy.” Provides for actions to promote job training in support of green economy.
- b. Minn. Stat. Ann. § 216H.03 (West 2007) (amended 2017): Excludes CO₂ captured and geologically sequestered for purposes of ban on constructing power plants that contribute to state carbon dioxide emissions.

15. Mississippi

- a. Miss. Code Ann. § 53-11-1 et seq. (West 2011): “Mississippi Geologic Sequestration of Carbon Dioxide Act.” Authorizes the State Oil and Gas Board to regulate carbon storage in the state, including by approving carbon storage facilities, regulating the use of carbon dioxide in enhanced oil recovery (EOR), maintaining compliance with Safe Drinking Water Act, and establishing bond or deposit requirements for operators. The legislative findings state, “Geologic

sequestration of carbon dioxide is an emerging industry that has the potential to provide jobs, investment, and other economic opportunities for the people of Mississippi, and is a valuable incentive for Mississippi to attract new industry.”

- b. Miss. Code Ann. § 27-65-19 (2013): Applies a significantly reduced sales tax rate to carbon dioxide sold to EOR projects or permanent geological sequestration. *See also* 32 Miss. Admin. Code Pt. IV, r. 6.01 (same).
- c. Miss. Code Ann. § 11-27-47 (West 1984): Empowers counties to regulate the construction and maintenance of CO₂ transmission pipelines.

16. Montana

- a. Mont. Code Ann. § 15-24-3111 (West 2007) (amended 2009): Provides a property tax abatement for coal gasification facilities CCS, as well as carbon dioxide sequestration equipment.
- b. Mont. Code Ann. § 15-6-158 (West 2007) (amended 2015): Provides 3% or lower tax rate for CO₂ sequestration equipment, CO₂ pipelines, and other specified property. (*See also* Mont. Admin. R. 36.22.1707 (2015) (implementing regulation on certifying CCS equipment for reduced tax rate).)
- c. Mont. Code Ann. § 69-8-421 (West 2007): Moratorium on new coal-fired power facilities, unless a facility captures and sequesters a minimum 50% CO₂ emissions, until such time as uniform federal or state standards for CCS are adopted. (*See also* Mont. Admin. R. 38.5.8228(2)(f) (2008) (implementing regulation requiring coal-fired plants to demonstrate 50% CCS in application to Commission).)
- d. Mont. Code Ann. § 69-13-101 et seq. (West 2013): Classifies and regulates CO₂ pipelines as common carriers, and authorizes the Public Service Commission to set rates of charge and promulgate operating rules for CO₂ pipelines.
- e. Mont. Code Ann. § 75-5-401 (West 2009): Exempts CO₂ injection wells from water permit requirements if they are properly permitted under oil and gas code.
- f. Mont. Code Ann. § 82-11-101 et seq. (West 2009): Provides for regulation of CO₂ wells by the Board of Oil and Gas Conservation, contingent on the U.S. EPA’s grant of primacy to administer activities at CO₂ sequestration wells.
 - i. Mont. Code Ann. § 82-11-111 (West 2009): Gives Board exclusive jurisdiction over CO₂ injection wells and geologic storage reservoirs, allowing the Board to issue permits, adopt design standards, and establish measures to prevent contamination, among other things.
 - ii. Mont. Code Ann. § 82-11-123 (West 2009): Specifies standards necessary for operation of CO₂ injection well including monitoring, recordkeeping, labeling and equipment.

- iii. Mont. Code Ann. § 82-11-127 (West 2009): Prohibits operation of a CO₂ well without a permit.
- iv. Mont. Code Ann. § 82-11-137 (West 2009): Requires operating fee for CO₂ injection well.
- v. Mont. Code Ann. § 82-11-183 (West 2009): Authorizes Board to issue completion certificates to wells that have completed injection of CO₂.
- vi. Mont. Code Ann. 82-11-184 (West 2009): Allows for conversion of EOR well to CO₂ storage well.
- g. Mont. Admin. r. 17.80.201 et seq. (2008) (amended 2011): Provides procedure for qualifying property CCS equipment and pipelines for property tax rates incentivizing geologic CO₂ sequestration.

17. New Hampshire

- a. N.H. Rev. Stat. Ann. § 125-O:22 (West 2008) (amended 2012): Allows electricity distribution companies to recover cost of CCS technologies through service charges.

18. New Mexico

- a. N.M. Stat. Ann. § 7-9G-2 (West 2007) (amended 2009): Provides tax credit incentive for coal-based generating plants achieving 1,100 lbs. CO₂/MWh, including through carbon capture and sequestration. (*See also* N.M. Stat Ann. §§ 7-9-114, 7-2-18.25, 7-2A-25 (providing similar tax credits); N.M. Stat. Ann. § 7-9J-4 (providing tax credits for CCS equipment in an IGCC coal plant).)
- b. N.M. Stat. Ann. § 62-6-28 (West 2007): Allows utilities to recover costs incurred for clean energy projects, including coal-based plants using CCS to achieve 1,100 lbs CO₂/MWh limit.

19. New York

- a. N.Y. Gen. Mun. L. § 959-b (West 2006) (amended 2009): Qualifies clean coal plants using CCS as “clean energy enterprises” eligible for state incentives.

20. North Dakota

- a. N.D. Cent. Code § 17-01-01 (West 2007): Adoption of 25x25 Initiative, which supports use of carbon sequestration as part of effort to get 25% of American energy from America’s renewable natural resources, while continuing to provide adequate food.

- b. N.D. Cent. Code § 38-22-01 et seq. (West 2009): The “Carbon Dioxide and Underground Storage” law’s policy declaration says that it is in the interest of North Dakota to promote geologic storage of carbon dioxide. Other sections provide for permitting procedures and requirements, environmental protection, fees based on tons of CO₂ stored, penalties for noncompliance, and conversion of EOR operations to CO₂ storage.
- c. N.D. Cent. Code § 57-06-17.1 (West 1991) (amended 1997), § 57-39.2-04.14 (West 2015): Exempts CO₂ pipeline property and equipment from utility taxes and sales and use taxes, respectively.
- d. N.D. Cent. Code § 57-60-02.1 (West 2009) (amended 2017): “Coal Conversion Facilities Tax.” Provides a 20%-50% tax credit to coal facilities that capture and store 20%-80% of their CO₂ emissions.
- e. N.D. Admin. Code 43-05-01-01 et seq. (2013): Provides permitting procedures and requirements for geologic storage of carbon dioxide, including environmental mandates, financial responsibility, recordkeeping and reporting. These regulations and the “Carbon Dioxide and Underground Storage” statutes formed the basis of EPA’s approval on April 24, 2018 of North Dakota’s state-administered Class VI underground injection control program.

21. Ohio

- a. Ohio Admin. Code r. 3745-51-04(H) (2015): Classifying injection of CO₂ streams for geological storage as Class VI injection wells subject to 40 C.F.R. § 261.4(h).

22. Oklahoma

- a. Okla. Stat. tit. 27A, § 3-4-101 et seq. (West 2001) (amended 2011): “Carbon Sequestration Enhancement Act.” Enacted to encourage carbon sequestration in Oklahoma, including via carbon capture and geologic storage, the act creates an inspection and certification program for carbon reserves.
- b. Okla. Stat. tit. 27A, § 3-5-101 et seq. (West 2009) (amended 2011): The “Oklahoma Carbon Capture and Geologic Sequestration Act” gives jurisdiction to the Corporation Commission to oversee CO₂ injections in oil or gas reservoirs and to the Department of Environmental Quality for any other geologic formations. Authorizes the respective agencies to conduct permitting and other regulation for CO₂ storage within their jurisdiction. The legislative findings state: “Storage of carbon dioxide in geological formations is an effective and feasible strategy to deposit, store or sequester large volumes of carbon dioxide over long periods of time.”
- c. Okla. Admin. Code § 155:30-1-1 et seq. (2009): Contains general provisions for voluntary carbon offset program, which may be implemented through geologic CO₂ sequestration, as well as other methods.

- d. Okla. Admin. Code § 155:30-13-1 et seq. (2009): Contains regulations specific to geologic carbon sequestration for carbon offset program, including fees, application requirements, monitoring provisions, and eligibility limitations.

23. Pennsylvania

- a. 71 Pa. Stat. Ann. § 1361.3 (West 2008): Authorizes Department of Environmental Protection to compose report on economic opportunities available to the state due to need for alternative energy, including “carbon sequestration technologies.” (*See also* 66 Pa. Stat. Ann. § 2815 (West 2008) (directing identification and assessment of Pennsylvania geologic formations for sequestration).)

24. Tennessee

- a. Tenn. Comp. R. & Regs. 0400-12-01-.02 (2015): Classifying injection of CO₂ streams for geological storage as Class VI injection wells subject to 40 C.F.R. Parts 144 and 146 and Tennessee underground injection control regulations.

25. Texas

- a. Tex. Nat. Res. Code Ann. § 120.001 et seq. (West 2009) (amended 2015): Creates a program to certify coal- and natural gas-fired plants that capture and sequester 70% CO₂ emissions for a “clean energy project” tax credit under Texas Tax Code § 171.602.
- b. Tex. Nat. Res. Code Ann. § 121.001 et seq. (West 2009) (amended 2011): Provides rules for ownership of CO₂ stored in geologic formations and creates trust fund funded through fees paid by CO₂ storage facility operators, used for monitoring, remediation, enforcement and other activities related to geologic CO₂ storage.
- c. Tex. Tax Code Ann. § 171.602 (West 2009): Provides a tax credit to clean energy projects that sequester at least 70% of CO₂ emissions.
- d. Tex. Tax Code Ann. § 202.0545 (West 2009): Provides a reduced tax rate for EOR projects that use and geologically sequester anthropogenic carbon dioxide. (*See also* Tex. Tax Code Ann. § 151.334 (West 2009) (exempting CCS equipment used in a clean energy project from sales and use taxes, if the captured CO₂ is either used in a local EOR project or sequestered in Texas for at least 1,000 years).)
- e. Tex. Water Code Ann. § 27.041 et seq. (West 2009): Gives jurisdiction over CO₂ injection to Railroad Commission and authorizes the Commission to permit, collect fees for, and prescribe operational standards for CO₂ storage facilities, including proof of “financial responsibility” from facility operators.

- f. Tex. Health & Safety Code Ann. § 382.501 et seq. (West 2009): “Offshore Geologic Storage of Carbon Dioxide.” Authorizes various state agencies to construct an offshore, deep subsurface geologic repository for carbon dioxide on state-owned land.
- g. 16 Tex. Admin. Code § 3.30 (2012): Memorandum of Understanding between the Railroad Commission of Texas and Texas Commission on Environmental Quality, recognizing Railroad Commission’s jurisdiction to regulate carbon dioxide sequestration wells per Texas Water Code § 27.041.
- h. 16 Tex. Admin. Code § 5.201 et seq. (2010), § 5.301 et seq. (2011): Regulates, respectively, the geologic sequestration of anthropogenic CO₂ in reservoirs and the use of anthropogenic CO₂ in EOR projects, with permit criteria and operational standards.
- i. 34 Tex. Admin. Code § 3.326 (2010): Provides tax exemptions for carbon capture and storage equipment and pipelines, if the CO₂ is sequestered in Texas.

26. Utah

- a. Utah Code Ann. § 10-19-101 et seq. (West 2008) (amended 2010): “Municipal Electric Utility Carbon Emission Reduction Act.” Requires that a certain portion of electricity supplied by municipal utilities be renewably sourced, with an allowed reduction for fossil-fuel generation that captures and geologically sequesters CO₂.
- b. Utah Code Ann. § 54-17-601 et seq. (West 2008) (amended 2010): “Carbon Emissions Reductions for Electrical Corporations.” Requires that a certain portion of electricity supplied by utilities be low- or no-emission electricity to the extent it is cost effective, including via carbon capture and storage.
- c. Utah Code Ann. § 54-17-701 (West 2008) (amended 2015): Directs various state agencies to recommend rules on permitting and operational standards for of CO₂ storage oversight.
- d. Utah Admin. Code r. R315-261-1 (2016): Classifying injection of CO₂ streams for geological sequestration as Class VI injection wells subject to Utah underground injection control regulations.

27. Vermont

- a. Vermont Admin. Code r. 16-3-303:11-201 (2014): Classifying injection of CO₂ streams for geological sequestration as Class VI injection wells subject to Vermont underground injection control regulations.

28. Virginia

- a. Va. Code Ann. § 56-585.1 (West 2007) (amended 2018): Allows enhanced cost recovery through utility rate adjustments for the construction of “carbon capture

compatible, clean-coal powered” power plants.

29. Washington

- a. Wash. Rev. Code Ann. § 80.70.010 et seq. (West 2004): Requires that newly proposed fossil fuels power plants include a carbon dioxide mitigation plan, which include a carbon capture and storage mechanism.
- b. Wash. Rev. Code Ann. § 80.80.030 (West 2007): Requires Governor to develop policy recommendations on methods to meet greenhouse gas reduction goals, including carbon capture and storage.
- c. Wash. Rev. Code Ann. § 80.80.040 (West 2007) (amended 2011): Institutes fossil-fueled generating plant emissions performance standard of 1,100 lbs CO₂/MWh that may be met in part through carbon capture and storage, including geologic sequestration.
- d. Wash. Admin. Code § 173-218-115 (2008): Contains permitting and regulatory requirements for carbon dioxide injection wells used for geological sequestration.
- e. Wash. Admin. Code § 173-407-100 et seq. (2008): Requires fossil-fueled thermal electric generating facilities of 25-350 MW capacity to implement CO₂ mitigation program, including through geologic or non-geologic sequestration. Limits CO₂ emissions to 1,100 lbs. CO₂/MWh from July 2008 – March 2018, then to 970 lbs. CO₂/MWh after March 2018.
- f. Wash. Admin. Code § 463-80-010 et seq. (2008): Implements carbon dioxide mitigation program for thermal electric generating facilities of greater than 350 MW capacity, and allows mitigation through geological carbon sequestration.

30. West Virginia

- a. W. Va. Code Ann. § 22-11A-1 et seq. (West 2009): “Carbon Dioxide Sequestration.” Establishes legal and regulatory framework for permitting of CO₂ sequestration sites. Empowers Dept. of Environmental Protection to permit and monitor carbon sequestration sites.
- b. W. Va. Code Ann. § 18B-1B-12 (West 2004): Creates research challenge fund to support research into coal technology, including carbon sequestration.

31. Wisconsin

- a. Wi. Stat. Ann. § 285.78 (1999): Creates a registry for persons to record voluntary greenhouse gas emissions reductions, through either carbon sequestration or energy efficiency measures, to show compliance with future state or federal limits. (*See also* Wi. Admin. Code § NR.437.01 et seq. (2002) (implementing regulations).)

32. Wyoming

- a. Wyo. Stat. Ann. § 30-5-502 (West 2015): Provides for Oil & Gas Conservation Commission to certify geologic CO₂ sequestration incidental to EOR operations.
- b. Wyo. Stat. Ann. § 34-1-152 (West 2008) (amended 2009), § 34-1-153 (West 2009): Resolves ownership of pore space under surfaces and ownership of CO₂ injected into pore space, for purposes of geologic sequestration.
- c. Wyo. Stat. Ann. § 35-11-313 *et seq.* (West 2008) (amended 2016): Requires permits for geologic CO₂ sequestration and creates special revenue account for deposit of permitting fees. Directs the Department of Environmental Quality to develop rules for operational standards, monitoring, and maintenance of injection wells.
- d. Wyo. R. & Regs. 055.0001.3 § 43 (2010) (amended 2016): Implements procedures for application and pooling of pore space to organize and operate a carbon dioxide geologic sequestration site.
- e. Wyo. R. & Regs. 020.0011.24 § 1 *et seq.* (2016): Creates operating standards, permitting procedures, and reporting and monitoring requirements for Class VI injection wells for the geologic sequestration of carbon dioxide.

(Continued on next page)

STATUTES AND REGULATIONS BY SUBJECT AREA

I. Permitting / Monitoring Rules and Procedures for CCS

1. Alabama

- a. Ala. Admin Code r. 335-6-8-.01 et seq. (2011) (amended 2015): Regulations for permitting, operating, and monitoring underground injection wells, including wells for permanent storage of carbon dioxide.

2. Illinois

- a. 220 Ill. Comp. Stat. Ann. § 75/1 et seq. (West 2011): “Carbon Dioxide Transportation and Sequestration Act.” Regulates the construction of pipelines to transport carbon dioxide to sequestration and enhanced oil recovery, as “critical to the promotion and use of Illinois coal.”
- b. 415 Ill. Comp. Stat. Ann. 5/13.7 (West 2011): Allows for inspection of carbon sequestration sites by IL EPA for water quality control purposes.
- c. Ill. Admin Code tit. 35, § 730, subpart H (2012) (amended 2018): Establishes criteria and standards for Class VI CO₂ geologic sequestration injection wells.
- d. Ill. Admin. Code tit. 83, 302.40 (2013) (amended 2014): Regulates the negotiation of easements by pipeline companies for development of a CO₂ pipeline from clean coal facilities to sequestration.

3. Indiana

- a. Ind. Code § 14-39-1-1 et seq. (West 2011): “Eminent Domain for Transportation of Carbon Dioxide by Pipeline” grants certified CO₂ pipeline company authority to condemn a right-of-way for construction of pipelines to transport CO₂ to EOR, deep saline injection, or sequestration, inside or outside Indiana.

4. Kentucky

- a. Ky. Rev. Stat. Ann. § 353.800 et seq. (West 2011): The “Geologic Storage of Carbon Dioxide” subsection of the Mines and Minerals Code states an explicit “economic priority” to attract CCS projects “that will create jobs ... and favorably position the Commonwealth for future leadership and growth in the field.” Other provisions relate to rights to ownership of pore space where carbon dioxide could be stored in geologic formations and monitoring requirements for sites where carbon dioxide has been stored.

5. Louisiana

- a. La. Rev. Stat. Ann. § 30:1101 et seq. (West 2009): “Louisiana Geologic Sequestration of Carbon Dioxide Act.” Section 1102 states that “[t]he geologic storage of carbon dioxide will benefit the citizens of the state and the state's environment by reducing greenhouse gas emissions.” Authorizes Commissioner of Conservation to regulate carbon storage through rules and regulations and provides various directions for the Commissioner. Releases operators from liability after completion of CO₂ injection operations.
- b. La. Rev. Stat. Ann. § 30:4 (West 2007): Authorizes Department of Conservation to regulation construction, design, and operation of pipelines transmitting CO₂ to EOR projects.
- c. La. Admin Code tit. 43, pt. XIX, § 403 (2016): Regulates the injection of CO₂ for EOR operations, including provisions to prevent or correct CO₂ leaks.
- d. La. Admin Code tit. 43, pt. XI, subpt. 4 (last amended 2017): Regulates the construction, design, and operation of CO₂ transmission pipelines, including detailed regulations on safety and maintenance.

6. Michigan

- a. Mich. Comp. L. Ann. § 483.3 (West 2014): Authorizes Public Service Commission to regulate CO₂ transmission pipelines.
- b. Mich. Admin. Code. r. 299.9204 (2016): Regulates CO₂ pipelines and injection wells as Class VI injection wells.

7. Mississippi

- a. Miss. Code Ann. § 53-11-1 et seq. (West 2011): “Mississippi Geologic Sequestration of Carbon Dioxide Act.” Authorizes the State Oil and Gas Board to regulate carbon storage in the state, including by approving carbon storage facilities, regulating the use of carbon dioxide in enhanced oil recovery (EOR), maintaining compliance with Safe Drinking Water Act, and establishing bond or deposit requirements for operators. The legislative findings state, “Geologic sequestration of carbon dioxide is an emerging industry that has the potential to provide jobs, investment, and other economic opportunities for the people of Mississippi, and is a valuable incentive for Mississippi to attract new industry.”
- b. Miss. Code Ann. § 11-27-47 (West 1984): Empowers counties to regulate the construction and maintenance of CO₂ transmission pipelines.

8. Montana

- a. Mont. Code Ann. § 82-11-101 et seq. (West 2009): Provides for regulation of CO₂ wells by the Board of Oil and Gas conservation, contingent on the U.S. EPA's grant of primacy to administer activities at CO₂ sequestration wells.
 - i. Mont. Code Ann. § 82-11-111 (West 2009): Gives Board exclusive jurisdiction over CO₂ injection wells and geologic storage reservoirs, allowing the Board to issue permits, adopt design standards, and establish measures to prevent contamination, among other things.
 - ii. Mont. Code Ann. § 82-11-123 (West 2009): Specifies standards necessary for operation of CO₂ injection well including monitoring, recordkeeping, labeling and equipment.
 - iii. Mont. Code Ann. § 82-11-127 (West 2009): Prohibits operation of a CO₂ well without a permit.
 - iv. Mont. Code Ann. § 82-11-137 (West 2009): Requires operating fee for injection well.
 - v. Mont. Code Ann. § 82-11-183 (West 2009): Authorizes Board to issue completion certificates to wells that have completed injection of CO₂.
 - vi. Mont. Code Ann. 82-11-184 (West 2009): Allows for conversion of EOR well to CO₂ storage well.
- b. Mont. Code Ann. § 69-13-101 et seq. (West 2013): Classifies and regulates CO₂ pipelines as common carriers, and authorizes the Public Service Commission to set rates of charge and promulgate operating rules for CO₂ pipelines.

9. North Dakota

- a. N.D. Cent. Code § 38-22-01 et seq. (West 2009): The "Carbon Dioxide and Underground Storage" law's policy declaration says that it is in the interest of North Dakota to promote geologic storage of carbon dioxide. Other sections provide for permitting procedures and requirements, environmental protection, fees based on tons of CO₂ stored, penalties for noncompliance, and conversion of EOR operations to CO₂ storage.
- b. N.D. Admin. Code 43-05-01-01 et seq. (2013): Provides permitting procedures and requirements for geologic storage of carbon dioxide, including environmental mandates, financial responsibility, recordkeeping and reporting.

10. Ohio

- a. Ohio Admin. Code r. 3745-51-04(H) (2015): Classifying injection of CO₂ streams for geological storage as Class VI injection wells subject to 40 C.F.R. § 261.4(h).

11. Oklahoma

- a. Okla. Stat. tit. 27A, § 3-5-101 et seq. (West 2009) (amended 2011): The “Oklahoma Carbon Capture and Geologic Sequestration Act” gives jurisdiction to the Corporation Commission to oversee CO₂ injections in oil or gas reservoirs and to the Department of Environmental Quality for any other geologic formations. Authorizes the respective agencies to conduct permitting and other regulation for CO₂ storage within their jurisdiction. The legislative findings state: “Storage of carbon dioxide in geological formations is an effective and feasible strategy to deposit, store or sequester large volumes of carbon dioxide over long periods of time.”
- b. Okla. Admin. Code § 155:30-13-1 et seq. (2009): Contains regulations specific to geologic carbon sequestration for carbon offset program, including fees, application requirements, monitoring provisions, and eligibility limitations.

12. Tennessee

- a. Tenn. Comp. R. & Regs. 0400-12-01-.02 (2015): Classifying injection of CO₂ streams for geological storage as Class VI injection wells subject to 40 C.F.R. Parts 144 and 146 and Tennessee underground injection control regulations.

13. Texas

- a. Tex. Nat. Res. Code Ann. § 121.001 et seq. (West 2009) (amended 2011): Provides rules for ownership of CO₂ stored in geologic formations and creates trust fund funded through fees paid by CO₂ storage facility operators, used for monitoring, remediation, enforcement and other activities related to geologic CO₂ storage.
- b. Tex. Water Code Ann. § 27.041 et seq. (West 2009): Gives jurisdiction over CO₂ injection to Railroad Commission and authorizes the Commission to permit, collect fees for, and prescribe operational standards for CO₂ storage facilities, including proof of “financial responsibility” from facility operators.
- c. 16 Tex. Admin. Code § 3.30 (2012): Memorandum of Understanding between the Railroad Commission of Texas and Texas Commission on Environmental Quality, recognizing Railroad Commission’s jurisdiction to the regulate carbon dioxide sequestration wells per Texas Water Code § 27.041.
- d. 16 Tex. Admin. Code § 5.201 et seq. (2010), § 5.301 et seq. (2011): Regulates, respectively, the geologic sequestration of anthropogenic CO₂ in reservoirs and

the use of anthropogenic CO₂ in EOR projects, with permit criteria and operational standards.

14. Utah

- a. Utah Admin. Code r. R315-261-1 (2016): Classifying injection of CO₂ streams for geological sequestration as Class VI injection wells subject to Utah underground injection control regulations.

15. Vermont

- a. Vermont Admin. Code r. 16-3-303:11-201 (2014): Classifying injection of CO₂ streams for geological sequestration as Class VI injection wells subject to Vermont underground injection control regulations.

16. Washington

- a. Wash. Admin. Code § 173-218-115 (2008): Contains permitting and regulatory requirements for carbon dioxide injection wells used for geological sequestration.

17. West Virginia

- a. W. Va. Code Ann. § 22-11A-1 et seq. (West 2009): “Carbon Dioxide Sequestration.” Establishes legal and regulatory framework for permitting of CO₂ sequestration sites. Empowers Dept. of Environmental Protection to permit and monitor carbon sequestration sites.

18. Wyoming

- a. Wyo. Stat. Ann. § 30-5-502 (West 2015): Provides for Oil & Gas Conservation Commission to certify geologic CO₂ sequestration incidental to EOR operations.
- b. Wyo. Stat. Ann. § 34-1-152 (West 2008) (amended 2009), § 34-1-153 (West 2009): Resolves ownership of pore space under surfaces and ownership of carbon dioxide injected into pore space, for purposes of geologic sequestration.
- c. Wyo. Stat. Ann. § 35-11-313 et seq. (West 2008) (amended 2016): Requires permits for geologic sequestration of CO₂ and creates special revenue account for deposit of fees from permitting. Directs the Department of Environmental Quality to develop rules for operational standards, monitoring, and maintenance of injection wells.
- d. Wyo. R. & Regs. 055.0001.3 § 43 (2010) (amended 2016): Implements procedures for application and pooling of pore space to organize and operate a carbon dioxide geologic sequestration site.

- e. Wyo. R. & Regs. 020.0011.24 § 1 *et seq.* (2016): Creates operating standards, permitting procedures, and reporting and monitoring requirements for Class VI injection wells for the geologic sequestration of carbon dioxide.

II. Recognizing Power Plants with CCS Under Low-Carbon Energy Laws

1. California

- a. Cal. Code Regs. tit. 17, § 95486 (2010) (amended 2019): California’s Low Carbon Fuel Standard incorporates credits for carbon capture and storage implemented in the fuel refinement process in determining a fuel’s carbon intensity.
- b. Cal. Code Regs. tit. 17, § 95852(g) (2012) (amended 2015): Carbon dioxide suppliers are regulated under California’s cap-and-trade program, but any carbon dioxide supplied that is ultimately geologically sequestered is not included in their compliance obligation (e.g., carbon dioxide supplied for enhanced oil recovery).
- c. Cal. Code Regs. tit. 20, § 2904 (2007): Carbon dioxide that is sequestered is not included in the CO₂ emissions compliance obligation for power plants.

2. Florida

- a. Fla. Stat. § 366.91 (West 2008) (amended 2010): Includes “electrical energy produced using pipeline-quality synthetic gas produced from waste petroleum coke with carbon capture and sequestration” in definition of “renewable energy” and requires utilities to offer to purchase renewable energy.

3. Illinois

- a. 20 Ill. Comp. Stat. Ann. 3855/1-75 (West 2009) (amended 2018): Subsection (d) requires a 5% clean coal portfolio standard for utilities and sets parameters for so-called “initial clean coal plants” that include at least 50% carbon capture and sequestration.
- b. 415 Ill. Comp. Stat. Ann. 5/9.10 (West 2001): Includes carbon sequestration as potential method for generation of voluntary emissions reduction credits.
- c. 220 Ill. Comp. Stat. Ann. 5/16-115 (West 2009) (amended 2015): In order to supply electricity to alternative retail electric suppliers as part of their renewable energy portfolios, clean coal facilities must either sequester 50% of CO₂ emissions or purchase offsets to cover any drop of the total emissions sequestered below 50%.
- d. Ill. Admin. Code tit. 83, Part 455 (2017): Prescribes standards for complying with renewable energy portfolio standard, including clean coal standard of 50% sequestration.

4. Maine

- a. Me. Rev. Stat. tit.38. § 585-K (West 2008): Subsection 4 provides that carbon dioxide that has been “captured and used for a commercial purpose” or “permanently disposed of in geological formations” shall not be counted as emissions for the purpose of the code.

5. Massachusetts

- a. Mass. Gen. Laws Ann. ch. 23J § 1 (West 2008) (amended 2009): Carbon capture and sequestration is included in the definition of “clean energy research” which may be supported by Massachusetts Alternative and Clean Energy Investment Trust Fund, which is created by this chapter.

6. Minnesota

- a. Minn. Stat. Ann. § 116J.437 (West 2008) (amended 2013): “Carbon capture, storage, or sequestration” is included in definition of “green economy.” Provides for actions to promote job training in support of green economy.
- b. Minn. Stat. Ann. § 216H.03 (West 2007) (amended 2017): Excludes CO₂ captured and geologically sequestered for purposes of ban on constructing power plants that contribute to state carbon dioxide emissions.

7. Montana

- a. Mont. Code Ann. § 69-8-421 (West 2007): Moratorium on new coal-fired power facilities, unless a facility captures and sequesters a minimum 50% CO₂ emissions, until such time as uniform federal or state standards for CCS are adopted. *See also* Mont. Admin. R. 38.5.8228(2)(f) (2008) (implementing regulation requiring coal-fired plants to demonstrate 50% CCS in application to Commission).

8. New York

- a. N.Y. Gen. Mun. L. § 959-b (West 2006) (amended 2009): Qualifies clean coal plants using CCS as “clean energy enterprises” eligible for state incentives.

9. Oklahoma

- a. Okla. Admin. Code § 155:30-1-1 *et seq.* (2009): Contains general provisions for voluntary carbon offset program which may be implemented through geologic sequestration of carbon as well as other methods.

10. Utah

- a. Utah Code Ann. § 10-19-101 *et seq.* (West 2008) (amended 2010): “Municipal Electric Utility Carbon Emission Reduction Act.” Requires that a certain portion of

electricity supplied by municipal utilities be renewably sourced, with an allowed reduction for fossil-fuel generation that captures and geologically sequesters CO₂.

- b. Utah Code Ann. § 54-17-601 et seq. (West 2008) (amended 2010): “Carbon Emissions Reductions for Electrical Corporations.” Requires that a certain portion of electricity supplied by utilities be low- or no-emission electricity to the extent it is cost effective, including via carbon capture and storage.

11. Washington

- a. Wash. Rev. Code Ann. § 80.70.010 et seq. (West 2004): Requires that newly proposed fossil fuels power plants include a carbon dioxide mitigation plan, which include a carbon capture and storage mechanism.
- b. Wash. Rev. Code Ann. § 80.80.040 (West 2007) (amended 2011): Institutes fossil-fueled generating plant emissions performance standard of 1,100 lbs. CO₂/MWh that may be met in part through carbon capture and storage, including geologic sequestration.
- c. Wash. Admin. Code § 173-407-101 et seq. (2008): Requires fossil-fueled thermal electric generating facilities of 25-350 MW capacity to implement CO₂ mitigation program, including through geologic or non-geologic sequestration. Limits CO₂ emissions to 1,100 lbs. CO₂/MWh from July 2008 – March 2018, then to 970 lbs. CO₂/MWh after March 2018.
- d. Wash. Admin. Code § 463-80-010 et seq. (2008): Implements carbon dioxide mitigation program for thermal electric generating facilities of greater than 350 MW capacity, and allows mitigation through geological carbon sequestration.

12. Wisconsin

- a. Wi. Stat. Ann. § 285.78 (1999): Creates a registry for persons to record voluntary greenhouse gas emissions reductions, through either carbon sequestration or energy efficiency measures, to show compliance with future state or federal limits. (*See also* Wi. Admin. Code § NR.437.01 et seq. (2002) (implementing regulations).)

III. Allowing Cost Recovery

1. Colorado

- a. Colo. Rev. Stat. § 40-2-123 (West 2006) (amended 2017): Provides framework for utility applications to build integrated gasification combined cycle plants with carbon capture capabilities and allows waiver of utility commission’s “rules requiring competitive resource acquisition” upon proper demonstration by utility. § 40-2-123(2)(f) allows full cost recovery from ratepayers for IGCC plants with carbon capture.

2. Florida

- a. Fla. Stat. § 366.8255 (West 2008) (amended 2012): Allows inclusion of “[c]osts or expenses prudently incurred for scientific research and geological assessments of carbon capture and storage” in utilities’ environmental compliance costs which may be recovered from ratepayers.

3. Illinois

- a. 20 Ill. Comp. Stat. Ann. § 687/6-5 (West 2007) (amended 2019): Provides funds from a ratepayer “Renewable Energy Resources and Coal Technology Development Assistance Charge” for capturing and sequestering CO₂ from coal combustion, and supporting research on CCS technology.

4. Iowa

- a. Iowa Code Ann. § 476.53 (West 2010) (amended 2018): Includes addition of carbon capture facility as significant alteration whose costs can be recovered from ratepayers.

5. Michigan

- a. Mich. Comp. L. Ann. § 460.1047 (West 2017): Allows power plants to recover costs of constructing and maintaining “advanced cleaner energy systems,” which include, in coal-fired plants, carbon capture and geologic sequestration of 85% or more CO₂ emissions.

6. New Hampshire

- a. N.H. Rev. Stat. Ann. § 125-O:22 (West 2008) (amended 2012): Allows electricity distribution companies to recover cost of CCS technologies through service charges.

7. New Mexico

- a. N.M. Stat. Ann. § 62-6-28 (West 2007): Allows utilities to recover costs incurred for clean energy projects, including coal-based plants using CCS to achieve 1,100 lbs. CO₂/MWh limit.

8. Virginia

- a. Va. Code Ann. § 56-585.1 (West 2007) (amended 2018): Allows enhanced cost recovery through utility rate adjustments for the construction of “carbon capture compatible, clean-coal powered” power plants.

IV. Proving Grants or Tax Incentives

1. Colorado

- a. Colo. Rev. Stat. § 25-1-1303 (West 2006): In 2006, provided \$50,000 grant to the Colorado School of Mines to research “geologic carbon sequestration as technique for mitigating the emissions of greenhouse gases in the state.”

2. Illinois

- a. 20 Ill. Comp. Stat. Ann. 3855/1-80 (West 2007) (amended 2016): Authorizes Illinois Power Agency to “develop, finance, construct, or operate” clean coal power plants and carbon sequestration facilities using Agency bonds.
- b. 20 Ill. Comp. Stat. Ann. § 687/6-5 (West 2007) (amended 2019): Provides funds from a ratepayer “Renewable Energy Resources and Coal Technology Development Assistance Charge” for capturing and sequestering CO₂ from coal combustion, and supporting research on CCS technology.
- c. 20 Ill. Comp. Stat. Ann. § 3501/825-65 (West 2010) (amended 2018): Authorizes state bonds to fund construction of clean coal plants using CCS.

3. Indiana

- a. Ind. Code § 8-1-8.8-12 (West 2011): “Utility Generation and Clean Coal Technology” subsection of Utilities and Transportation Code. The subsection provides financial incentives for utilities building ‘new energy’ generators, including CCS coal plants.

4. Iowa

- a. Iowa Admin. Code r. 261-401.6 (2011): Makes energy projects implementing carbon capture and storage eligible for financial assistance.

5. Kansas

- a. Kan. Stat. Ann. § 79-233 (West 2007): Exempts “any carbon dioxide capture, sequestration or utilization property,” including equipment, injection wells, and electric generation units with 100% carbon capture, from property taxes.
- b. Kan. Stat. Ann. § 79-32,256 (West 2007): Provides tax deduction for CCS equipment.

6. Kentucky

- a. Ky. Rev. Stat. Ann. § 154.27-010 *et seq.* (West 2007) (amended 2011): “Incentives for Energy Independence Act.” Provides incentives, including income and sales tax credits up to 100%, for carbon capture-ready projects,

defined as those built with “planning for or anticipating capture of carbon dioxide in a manner to facilitate continued operation of the facility in compliance with applicable federal requirements.” (*See also* Ky. Rev. Stat. Ann. § 143.31-010 *et seq.* (2018) (providing tax incentives for, among other projects, a CO₂ pipeline).)

- b. Ky. Rev. Stat. Ann. § 154.31-020 (West 2018): Makes CO₂ transmission pipeline companies eligible for sales and use tax incentives under the Kentucky Investment Act.

7. Louisiana

- a. La. Rev. Stat. Ann. § 30:209 (West 2008) (amended 2009): Authorizes State Mineral and Energy Board, among other powers, to “enter into operating agreements whereby the state receives a share of revenues from the storage of oil, natural gas, liquid or liquefied hydrocarbons, or carbon dioxide.” Includes as an example “[e]stablishing a contractual agreement for the operation of a carbon dioxide storage facility for the storage and distribution of carbon dioxide for secondary or tertiary recovery operations.”
- b. La. Rev. Stat. Ann. § 633.4 (West 2009): Provides a 50% tax reduction on EOR projects that use anthropogenic carbon dioxide.

8. Michigan

- a. Mich. Comp. L. Ann. § 205.303 (West 2014): Grants a reduced severance tax rate to approved EOR projects using carbon dioxide injection.

9. Mississippi

- a. Miss. Code Ann. § 27-65-19 (2013): Applies a significantly reduced sales tax rate to carbon dioxide sold to EOR projects or permanent geological sequestration. *See also* 32 Miss. Admin. Code Pt. IV, r. 6.01 (same).

10. Montana

- a. Mont. Code Ann. § 15-24-3111 (West 2007) (amended 2009): Provides a property tax abatement for coal gasification facilities with carbon capture and sequestration, as well as carbon dioxide sequestration equipment.
- b. Mont. Code Ann. § 15-6-158 (West 2007) (amended 2015): Provides 3% or lower tax rate for CO₂ sequestration equipment, carbon dioxide pipelines, and other specified property. (*See also* Mont. Admin. R. 36.22.1707 (2015) (implementing regulation on certifying CCS equipment for reduced tax rate).)
- c. Mont. Code Ann. § 75-5-401 (West 2009): Exempts CO₂ injection wells from water permit requirements if they are properly permitted under oil and gas code.

- d. Mont. Admin. r. 17.80.201 et seq. (2011): Provides procedure for qualifying CO₂ sequestration equipment and pipelines for property tax rates incentivizing geologic CO₂ sequestration.

11. New Mexico

- a. N.M. Stat. Ann. § 7-9G-2 (West 2007) (amended 2009): Provides tax credit incentive for coal-based generating plants achieving 1,100 lbs. CO₂/MWh, including through carbon capture and sequestration. (*See also* N.M. Stat. Ann. §§ 7-9-114, 7-2-18.25, 7-2A-25 (providing similar tax credits); N.M. Stat. Ann. § 7-9J-4 (providing tax credits for CCS equipment in an IGCC coal plant).)

12. North Dakota

- a. N.D. Cent. Code § 57-60-02.1 (West 2009) (amended 2017): “Coal Conversion Facilities Tax.” Provides a 20%-50% tax credit to coal facilities that capture and store 20%-80% of their CO₂ emissions.
- b. N.D. Cent. Code § 57-06-17.1 (West 1991) (amended 1997), § 57-39.2-04.14 (West 2015): Exempts CO₂ pipeline property and equipment from utility taxes and sales and use taxes, respectively.

13. Oklahoma

- a. Okla. Stat. tit. 27A, § 3-4-101 et seq. (West 2001) (amended 2011): “Carbon Sequestration Enhancement Act.” Enacted to encourage carbon sequestration in Oklahoma, including via carbon capture and geologic storage, the act creates an inspection and certification program for carbon reserves.

14. Texas

- a. Tex. Health & Safety Code Ann. § 382.501 et seq (West 2009): “Offshore Geologic Storage of Carbon Dioxide.” Authorizes various state agencies to construct an offshore, deep subsurface geologic repository for carbon dioxide on state-owned land.
- b. Tex. Tax Code Ann. § 171.602 (West 2009): Provides a tax credit to clean energy projects that sequester at least 70% of CO₂ emissions.
- c. Tex. Tax Code Ann. § 202.0545 (West 2009): Provides a reduced tax rate for EOR projects that use and geologically sequester anthropogenic carbon dioxide. (*See also* Tex. Tax Code Ann. § 151.334 (West 2009) (exempting CCS equipment used in a clean energy project from sales and use taxes, if the captured CO₂ is either used in a local EOR project or sequestered in Texas for at least 1,000 years).)
- d. 34 Tex. Admin. Code § 3.326 (2010): Provides tax exemptions for carbon capture and storage equipment.

15. West Virginia

- a. W. Va. Code Ann. § 18B-1B-12 (West 2004): Creates research challenge fund to support research into coal technology, including carbon sequestration.

Summary Table

	AL	CA	CO	FL	IL	IN	IA	KS	KY	LA	ME	MA	MI	MN	MS	MT	NH	NM	NY	ND	OH	OK	PA	TN	TX	UT	VT	VA	WA	WV	WI	WY
I. Regulates CCS operations	•				•	•			•	•			•		•	•				•	•	•		•	•	•	•		•	•		•
Regulates injection wells	•				•				•	•			•		•	•				•	•	•		•	•	•	•		•	•		•
Regulates pipelines					•	•				•			•		•	•																
II. Recognizes CCS under low carbon laws		•		•	•						•	•		•		•			•			•				•			•		•	
Voluntary offset programs					•																	•									•	
III. Allows cost recovery			•	•	•		•						•				•	•										•				
IV. Grants or tax incentives			•		•	•	•	•	•	•			•		•	•		•		•		•				•				•		
Incentives for construction of new CCS facility or pipeline					•	•			•	•															•							
Incentives based on emission limits or capture rates																		•		•					•							
Direct public investment in CCS facilities					•					•															•							