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Chapter 13: How Existing Environmental Laws Respond to Climate Change and Its Mitigation

by Justin Gundlach*

Abstract

Existing environmental laws interact with public health priorities and with aspects of the changing climate in numerous and varied ways. This chapter does not attempt to catalogue those interactions, but instead focuses on two that are especially important and illustrative of the operation and limitations of existing environmental laws vis-à-vis climate change-driven challenges. The first interaction is between pollution levels boosted by climate change and pollution control laws that employ health-based standards to determine pollution limits. The second is between a wider array of existing laws and the effects of climate change mitigation measures on public health. Examining these interactions reveals the inadequacy of existing laws to the tasks of 1) tracking the public health impacts of—much less adapting to—climate change, and 2) ensuring that climate change mitigation efforts reflect a rational accounting of impacts on public health, whether from foregoing mitigation or undertaking it.

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Introduction

Existing environmental laws interact with public health priorities and with aspects of the changing climate in numerous and varied ways. This chapter does not attempt to catalogue those interactions, but instead focuses on two that are especially important and illustrative of the operation and limitations of existing environmental laws vis-à-vis climate change-driven challenges. The first interaction is between pollution levels boosted by climate change and pollution control laws that employ health-based standards to determine pollution limits. The second is between a wider array of existing laws and the effects of climate change mitigation measures on public health. Examining these interactions reveals the inadequacy of existing laws to the tasks of 1) tracking the public health impacts of—much less adapting to—climate change, and 2) ensuring that climate change mitigation efforts reflect a rational accounting of impacts on public health, whether from foregoing mitigation or undertaking it.

I. Pollution control statutes: climate change and the amplification of public health impacts

As climate change alters the pathways through which pollution arrives at points of contact with people, it often causes the same volume of released pollution to result in a higher degree of human exposure. For instance, the same volume of agricultural runoff will generate more—and more virulent—algae in warmer water.[1] The case is similar for ozone, which forms more readily from the same quantity of precursors amid higher ambient air temperatures. Thus, as the U.S. Global Change Research Program's assessment of climate change and health concludes: "Climate change will make it harder for any given regulatory approach to reduce ground-level ozone pollution in the future as meteorological conditions become increasingly conducive to forming ozone over most of the United States."[2] The report also points out the clear and unavoidable implication of this trend: "*Unless offset by additional emissions reductions*, these climate-driven increases in ozone will cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms."[3] But pollution control statutes will not automatically effectuate those offsetting reductions, whether in relation to ozone formation or other forms of

[1] *See* Rob Herman, *Toxic Algae Blooms Are on the Rise*, Scientific American (Blog), Sept. 7, 2016, https://perma.cc/5D3U-FMF2; *see also* Robin Kundis Craig, *Climate Change Comes to the Clean Water Act: Now What?*, Wash. & Lee J. Energy, Climate, & Env't 9, 28–31 (2009) ("if waters are warming because of both climate change impacts and discharges of heated effluent, reducing the point source discharges may forestall the worst effects of increasing temperatures and hence increase the resilience of the species and ecosystems in those waters.").

[2] U.S. Global Change Research Program, Climate and Health Assessment, Key Finding 1: Exacerbated Ozone Health Impacts, https://health2016.globalchange.gov/air-quality-impacts#finding-42 (emphasis added).

[3] *Id.*

pollution. Indeed, it is unlikely that they will even signal clearly that such reductions are necessary to maintain the current public health status quo.[4]

With the exception of the Endangered Species Act, which focuses on the protection of other species, environmental protection statutes—and certainly all pollution control statutes—make their basic objective the protection of public health and welfare. Pollution control statutes, however, apply different standards to the protections they impose.[5] Under the Clean Air Act, for instance, standards fall into three categories. Some are set using a cost-benefit analysis that balances public health risks against polluters' costs. Others are set based on "feasibility," meaning that polluters must use whatever pollution control technologies have been shown to be both maximally effective and not so expensive as to drive an industry into bankruptcy. Still others—of particular interest in this chapter—are "health-based," meaning that they are to reflect the level of pollution that research has identified as safe for humans to encounter in the ambient environment.

A limit prescribed by this third category starts with a fixed value, often derived from dose-response or concentration-response curves that measure the correlation between the risk of a particular adverse health outcome and increasing levels of exposure to a particular pollutant.[6] Levels of risk on a dose-response curve are sensitive to the concentration of a given pollutant and the status of the human exposed to it (e.g., child, immuno-compromised, pregnant, exercising[7]), but are generally abstracted from circumstances at the point of exposure, like the ambient air temperature. In addition to this fixed, abstract value, pollution limits also incorporate factors that reflect how the pollution at issue enters, travels through, and persists in the ambient environment. While climate change does not affect the fixed value, it does alter the dynamic ones.[8]

A. Two examples of health-based standards amid a changing climate

The following examples—the Clean Air Act's regulation of ground-level ozone and the Resource Conservation and Recovery Act's regulation of coastal hazardous waste transfer and storage facilities—illustrate how health-based standards *could* make pollution control laws a spur to adaptation.[9]

[4] At least one commentator goes a step farther, arguing that the environmental impacts of climate change will both exacerbate pollution and dampen public support for effective environmental regulation. Matthew D. Zinn, *Adapting to Climate Change: Environmental Law in a Warmer World*, 34 Ecology L.Q. 61, 65 (2007).

[5] Congressional Research Service, Cost and Benefit Considerations in Clean Air Act Regulations 3–7 (May 2017), https://perma.cc/YMH9-DVF6 (listing statutory provisions that instruct, permit, or prohibit the Administrator from taking cost into account when setting a particular standard).

[6] *See, e.g.*, EPA, Integrated Science Assessment of Ozone and Related Photochemical Oxidants 2-32 to 2-34 (2013).

[7] *Id.* at 5-18 to 5-19 (discussing effects of activity); 5-64 to 5-67 (discussing effects of lifestage).

[8] *See* P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 5863 Science 573–74 (Feb. 2008) (discussing disruptive effects of climate change on models that inform water policy).

[9] *See* Daniel A. Farber, *Climate Adaptation and Federalism: Mapping the Issues*, 1 San Diego J. Climate & Energy L. 259, 266 (2009) ("climate impacts might be managed in part through current federal law.").

1. Ground-level ozone under the Clean Air Act

Ground-level ozone does not emerge from smoke stacks or tailpipes, but rather forms when nitrogen oxide (NOx) and volatile organic compounds (VOCs)—which do emerge from smoke stacks or tailpipes—comingle in the presence of sunlight or another heat source.[10] Thus, even if levels of NOx and VOCs remained flat in the coming decades, ozone's prevalence in the ambient air would likely grow as average temperatures rise across the U.S.[11] Notably, over the past several decades, levels of ozone in the ambient air have fallen far less than other pollutants subject to regulation under the Clean Air Act.[12]

The Clean Air Act directs EPA and the various states to take a series of regulatory steps with respect to ground-level ozone.[13] The first is adoption by EPA of a National Ambient Air Quality Standard (NAAQS)—a health-based limit above which concentrations of ground-level ozone in the ambient air have been shown to do harm to public health and welfare.[14] To determine that limit, EPA seeks the advice of the Clean Air Scientific Advisory Committee (CASAC), which evaluates available scientific evidence and issues recommendations about where the limit should fall and how to measure compliance with it.[15] The Clean Air Act, as interpreted by the Supreme Court, directs EPA to treat ozone as a "non-threshold contaminant," meaning that the NAAQS for ozone can theoretically be set to zero.[16] Once the NAAQS is set, other components of the Clean Air Act's machinery make it a national yardstick: areas where ozone concentrations do not exceed it are in "attainment," and those few areas where ozone concentrations do exceed it are in "nonattainment."[17] (See Figure 1.)

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[10] EPA, Ozone Pollution: Ozone Basics, https://perma.cc/3EEW-2ZKZ (updated Apr. 5, 2017).

[11] *See, e.g.*, Perry E. Sheffield et al., *Modeling of Regional Climate Change Effects on Ground-Level Ozone and Childhood Asthma*, 41 Am. J. Preventive Med. 251, 255 (2011), https://perma.cc/93RP-W2YP (estimating increases in emergency room visits to treat acute episodes of pediatric asthma due to effects of climate change on ozone formation).

[12] EPA, *Air Trends: Air Quality-Trends and Summary*, https://perma.cc/SA4C-QNCR (last updated July 26, 2017).

[13] EPA, *Process of Reviewing the National Ambient Air Quality Standards*, https://perma.cc/8ZRK-FW7F (last updated Dec. 1, 2016).

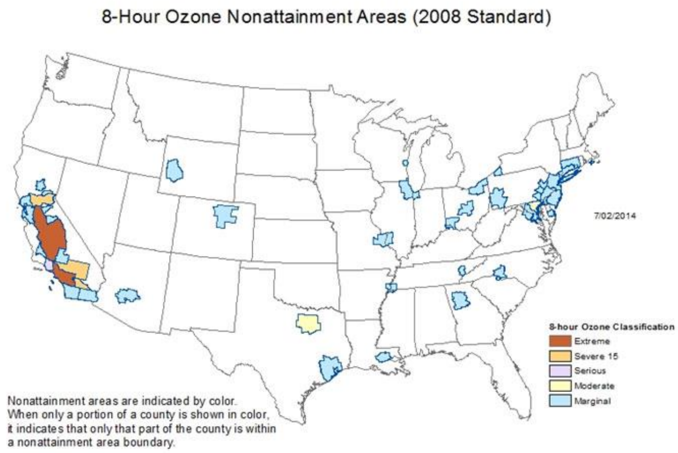
[14] *See* Clean Air Act §§ 108, 109; 40 C.F.R. §§ 50.09 (primary ozone NAAQS), 50.10 (secondary).

[15] Clean Air Act § 109(d)(2) (establishing independent scientific review committee to recommend new or updated NAAQS to EPA Administrator); EPA Clean Air Scientific Advisory Committee (CASAC): Charter, https://perma.cc/E5UA-UTFL (visited June 9, 2017); *see also* Integrated Science Assessment (ISA) of Ozone and Related Photochemical Oxidants (Final Report, Feb 2013): History/Chronology (Apr. 4, 2017), https://perma.cc/4JZN-V6JY; EPA, 78 Fed. Reg. 11,172, 11,172 (Feb. 15, 2013) (describing steps of ozone NAAQS development involving CASAC). *But see also* Michael A. Livermore & Richard L. Revesz, *Rethinking Health-Based Environmental Standards*, 89 N.Y.U. L. Rev. 1184 (2014) (criticizing EPA's approach to deriving nominally health-based NAAQS in a way that manifestly but secretly takes non-health factors into account).

[16] *See* American Trucking Ass'ns v. EPA, 175 F.3d 1027, 1034 (D.C. Cir. 1999), *rev'd on other grounds sub nom* Whitman v. American Trucking Ass'ns (2001) (citing 62 Fed. Reg. 38,863 (July 18, 1997) and 61 Fed. Reg. 65,637, 65,651 (1996)). Livermore and Revesz have pointed out that EPA does not actually adhere to the logic of a "non-threshold" health-based standard with respect to all non-threshold pollutants and often adopts limits that reflect other considerations as well. Michael A. Livermore & Richard L. Revesz, *Rethinking Health-Based Environmental Standards*, 89 N.Y.U. L. Rev. 1184, 1188–89, 1246 (Oct. 2014).

[17] 40 C.F.R. § 51.491 (defining "attainment area" and "nonattainment area").

Figure 1. U.S. counties, by attainment status under 2008 8-hour ozone standard[18]



As Figure 1 shows, there are gradations of nonattainment, ranging from marginal to extreme. Different rules apply to sources of pollutants that generate ozone precursors in attainment and nonattainment areas; the rules governing nonattainment areas reflect the extremity of each area's noncompliance.[19] Perhaps most importantly for this chapter's purposes, in nonattainment areas, major new or modified emitting facilities may only receive a permit to pollute if they demonstrate that they will achieve the Lowest Achievable Emission Rate, which the Clean Air Act defines as either the most stringent emission limitation prescribed by any state for that source category, or the most stringent limitation actually achieved by that source category.[20]

Actually dealing with sources of ozone precursors is a task for the state agencies that update and enforce compliance with State Implementation Plans (SIPs), and for the state attorneys general who seek to enforce compliance by other states with the Cross State Air Pollution Rule's restrictions on emissions that make downwind state's compliance with their own SIPs more difficult.[21] While states operate with guidance and subject to EPA oversight,[22] their approaches are not mechanistic, even with respect to measuring pollution levels, which has been shown to be strategic: in marginal areas, the strategy aims to avoid thresholds for a higher

[18] U.S. EPA Green Book, https://perma.cc/X3V3-KNS5 (updated Sept. 30, 2017; showing areas designated nonattainment by EPA as of June 20, 2017).

[19] 42 U.S.C. §§ 7501–7515 (prescribing state implementation plan requirements for nonattainment areas); *id.* § 7511d (imposing fines on exceedence of prescribed limits in severe or extreme nonattainment areas).

[20] 42 U.S.C. § 7501(3).

[21] *See, e.g.*, Complaint for Injunctive Relief, Maryland v. Pruitt, 1:17-cv-02873-JKB (D. Md. Sept. 27, 2017) (alleging that NOx emissions from at least 36 power plants in upwind states constitute a violation of the Clean Air Act's "good neighbor" provision).

[22] *See* EPA, Technology Transfer Network / NAAQS Ozone Implementation: Related Documents and Data, https://archive.epa.gov/ttn/ozone/web/html/related-3.html (last updated Feb. 21, 2016) (collecting federal guidance and state-submitted documents).

category of classification.[23] Similarly, state-level action to address pollution does not follow uniformly or straightforwardly from setting a NAAQS, but often reflects diverse approaches of variable rigor.[24]

2. The Resource Conservation and Recovery Act and coastal hazardous waste facilities

"[The Resource Conservation and Recovery Act (RCRA)]'s primary purpose . . . is to reduce the generation of hazardous waste and to ensure the proper treatment, storage, and disposal of that waste which is nonetheless generated, 'so as to minimize the present and future threat to human health and the environment.'"[25] To accomplish this goal, which expressly contemplates future circumstances but says nothing about climate change, RCRA imposes various requirements on the entities involved in managing solid or hazardous wastes.[26] Some of those requirements relate to the detailed tracking of wastes, which in turn facilitates identification of instances of "release," i.e., failures to prevent those wastes from migrating out of the containers, tanks, or impoundments used to transport, store, or dispose of them. Other requirements relate to facility design and management; as New Jersey's Department of Environmental Protection summarizes, a RCRA permit "outlines facility design and operation, lays out safety standards, and describes activities that the facility must perform, such as monitoring and reporting. Permits typically require facilities to develop emergency plans, find insurance and financial backing, and train employees to handle hazards."[27]

Much as rising temperatures promise to generate more ground-level ozone from the same volume of NOx and VOCs, rising sea levels promise to heighten the prospective risk of release at coastal hazardous waste facilities due to various forms of flooding—risks illustrated dramatically by Hurricane Harvey's inundation of multiple facilities near Houston.[28] And, much as the Clean Air Act sets forth fixed pollutant concentration standards based on human health impacts, RCRA establishes a standard that is also based on human health and would seem to transcend particular

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[23] Corbett Grainger et al., How States Comply with Federal Regulations: Strategic Ambient Pollution Monitoring (Oct. 2016), https://perma.cc/A4WP-JH3L (finding that state and local authorities place monitoring stations strategically to affect results).

[24] Jinghui Lim, *The impact of monitoring and enforcement on air pollutant emissions*, 49 J. Reg'y Econ. 203, 220 (Apr. 2016), https://perma.cc/7LQ3-VC7U (identifying deterrent effect from different levels of penalties imposed by state agencies on NOx emitters); EPA, Office of Inspector General, EPA and States Not Making Sufficient Progress in Reducing Ozone Precursor Emissions in Some Major Metropolitan Areas, Report No. 2004-P-00033 (Sept. 29, 2004).

[25] Meghrig v. KFC W., Inc., 516 U.S. 479, 483 (1996) (quoting 42 U.S.C. § 6902(b)); *see also* 42 U.S.C. § 6901 et seq.

[26] RCRA § 3019, 42 U.S.C. § 6939a(a) (requiring applicant seeking a permit for new landfill or surface impoundment facility that will contain hazardous waste to submit an assessment of public exposure from "reasonably foreseeable potential releases" that are "related to the unit.").

[27] New Jersey Department of Environmental Protection, Waterfront Permitting Made Simple (or at Least Simpler): The Guide to New York City and New Jersey Waterfront Permitting, https://perma.cc/7F62-GNNV (accessed June 12, 2017).

[28] Ralph Vartabedian, *Harvey pounded the nation's chemical epicenter. What's in the foul-smelling floodwater left behind?*, L.A. Times, Aug. 31, 2017, https://perma.cc/MY5G-8R24.

environmental circumstances. However, the differences between the two statutes' health-related standards are significant as well. Whereas the Clean Air Act bases source-specific pollution limits on the numbers and testing protocols specified in a NAAQS, RCRA articulates its health-related basic standard not as a numeric threshold, but in its definition of entities potentially subject to a citizen suit:

> any past or present generator, . . . transporter, or . . . owner or operator of a treatment, storage, or disposal facility, who has contributed or who is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an *imminent* and *substantial endangerment* to health or the environment.[29]

Because various courts' applications of this standard give it meaning, the "threshold" it provides for separating compliant from noncompliant conduct is sometimes fuzzy and frequently contested—especially the terms emphasized with italics above.

In the context of rising sea levels and encroaching shorelines, does this definition effectively require coastally-sited permit holders to adapt or else be found to be the source of imminent and substantial endangerments to the health of nearby individuals and communities? The case, *Conservation Law Foundation v. ExxonMobil*, which has survived a motion to dismiss as of September 2017,[30] addresses this question in the context of the Everett Terminal, a coastal petroleum transfer and storage facility located near Boston. CLF asserts that downscaled climate models make clear that the facility is already vulnerable to flooding in ways that ExxonMobil has not addressed.[31] ExxonMobil responds that it complies with the requirements of the facility's permit—which does not expressly contemplate climate change impacts—and therefore cannot be in violation of RCRA.[32] Because the basic RCRA standard at issue is not a pollution concentration threshold against which compliance can be measured with precision, resolution by the courts will be based on a legal analysis as well as—and possibly more so than—empirical measurements.

B. Pollution control laws and stationarity

Climate change is replacing stable historical environmental baselines with dynamic ones. This point is almost a tautology, but it does not guarantee that those responsible for enforcing environmental laws will abandon the premise of environmental stationarity that tacitly informs

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[29] RCRA § 7002(a)(1)(B), *codified at* 42 U.S.C. § 6972(a)(1)(B) (emphasis added).

[30] Order, Conservation Law Foundation, Inc. v. ExxonMobil Corp. et al., C.A. No. 1:16-cv-11950-MLW (D. Mass. Sept. 13, 2017).

[31] Complaint for Declaratory and Injunctive Relief and Civil Penalties, Conservation Law Foundation, Inc. v. ExxonMobil Corp., C.A. No. 1:16-cv-11950-MLW (D. Mass. Sept. 29, 2016).

[32] Memorandum of Law in Support of Defendants' Motion to Dismiss, Conservation Law Foundation, Inc. v. ExxonMobil Corp., C.A. No. 1:16-cv-11950-MLW (D. Mass. Dec. 6, 2016).

most pollution control laws.[33] As the examples discussed above show, mere evidence of stationarity's obsolescence is not enough. Strong signals that existing pollution control will become increasingly ineffective without more stringent and aggressive enforcement have not (yet) altered the approaches taken by federal and state agencies to applying existing environmental laws to pollution in a changing environmental context. This is understandable in so far as law enforcement takes direction from policy makers; if policy makers in agencies ignore—or are prevented from acting on—those signals, a course correction will only come from accumulated courtroom defeats or legislation.

The still-unresolved questions of whether and how GHG emissions are to be regulated under the Clean Air Act hint at what we can expect of the coming fights—like *CLF v. ExxonMobil*—over applying environmental laws in ways that respond to changing environmental conditions. The Supreme Court's 2007 decision in *Massachusetts v. EPA* started the wheels of the Clean Air Act turning,[34] but now, more than 10 years later, U.S. political leaders dispute the scientific consensus underlying that decision and have debated internally how best to apply the Act so as to avoid regulating GHG emissions with any material effect.[35] This persistent political ambivalence over climate change mitigation policy does not augur well for the application of existing environmental laws—directly or indirectly—to effectuate adaptation goals. This is not only because it demonstrates political leaders and policy makers' willingness to ignore evidence, but also and no less importantly because causation in the adaptation context is less straightforward than in the context of mitigation: dozens of noisy factors accompany the signal of a warmer climate amplifying the contribution of pollution precursors to human exposure to pollution. Thus, while environmental laws can be expected to be a source of partial information as the climate changes, environmental enforcement agencies' understanding and application of those laws should not be expected to evolve without conscious intervention at least by regulatory policy makers and likely, eventually, by legislators as well.

II. Public health co-benefits and co-harms of climate change mitigation measures

Positive and negative public health impacts can be expected to result from mitigation efforts,[36] but the scales are not balanced: mitigation is likely to yield far more positive public health impacts than negative ones. Current law credits only some of the positive impacts and fails to anticipate or avoid many of the negative ones. This section considers several likely public

[33] *See* P.C.D. Milly et al., *supra* note 8;.

[34] 594 U.S. 497 (2007).

[35] Andrew Resuccia & Alex Guillen, *Pruitt takes fire from conservatives in climate showdown*, Politico, Mar. 28, 2017, https://perma.cc/K53Q-ZHBR (describing debate among climate skeptics within EPA over tactical efficacy of trying to rescind the 2009 endangerment finding on which mitigation under the Clean Air Act is based).

[36] Kirk R. Smith et al., *Energy and Human Health*, 34 Ann. Rev. Pub. Health 159 (Mar. 2013), DOI: 10.1146/annurev-publhealth-031912-114404.

health impacts of mitigation—co-benefits first, then co-harms—and describes how the law takes them into account.

Before considering examples of co-benefits and co-harms from mitigation, it is important to first note that this chapter borrows from the Deep Decarbonization Pathways Project for its vision of the potential scale and scope of mitigation efforts in the United States over the coming decades.[37] That vision entails large investments in energy efficiency, the electrification of the transportation and building sectors, and the near-total replacement of fossil-fueled electricity generation with renewable and non-emitting sources.[38] Putting this borrowed vision in the background of this chapter clarifies the degree of mitigation currently thought possible without basic disruptions to the economy and society. This in turn anticipates (and refutes) the suggestion that because fossil fuels have played an important role historically in improving public health it is not possible to decouple future economic and societal development—and concomitant improvements to public health—from reliance on fossil fuels.

A further preliminary note relates to this chapter's geographic focus on the U.S., which has important implications for the types of climate mitigation co-benefits and co-harms considered herein.[39] Some forms of mitigation have very different public health implications in the U.S. as compared to the developing world. An especially clear example is the climate and public health tradeoff related to air conditioning (AC). As a changing climate leads to warmer average temperatures and more frequent and intense heat waves, access to AC will become increasingly important to public health outcomes (see Chapter 7). Most AC units currently rely on the compression of fluorinated gases (F-gases) to generate cool air.[40] Unfortunately, f-gases' extremely large global warming potential (GWP) co-efficients make them a threat to climate stability.[41] AC is widely available in those parts of the U.S. that experience hot weather, but not in the developing world. Recent examples from Pakistan and India,[42] and elsewhere,[43] illustrate

[37] *See* J.H. Williams et al. Pathways to deep decarbonization in the United States: The U.S. report of the Deep Decarbonization Pathways; Project of the Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations (Nov. 2015), https://perma.cc/92LD-G6VN (describing pathways by which the U.S. could reduce its annual GHG emissions by 80% below 1990 levels by 2050).

[38] *Id.* at vii.

[39] *See, e.g.*, Damilola Olawuyi, *Climate justice and corporate responsibility: taking human rights seriously in climate actions and projects*, 34 J. Energy & Nat. Resources L. 1-18 (2016) (describing adverse impacts of climate mitigation projects); Damilola Olawuyi, *Fostering Accountability in Large Scale Environmental Projects: Lessons from CDM and REDD+ Projects*, in Improving Delivery in Development: The Role of Voice, Social Contract, and Accountability 127–47 (J Wouters et al. eds. 2015).

[40] O. Abdelaziz, W. Goetzler et al., The Future of Air Conditioning for Buildings (July 2016), https://perma.cc/959T-JJKD.

[41] *See* Pallav Purohit and Lena Höglund-Isaksson, *Global emissions of fluorinated greenhouse gases 2005–2050 with abatement potentials and costs*, 17 Atmos. Chem. Phys. 2795, 2804 (2017) (estimating changes in f-gas emissions by region under different scenarios).

[42] Michael Wehner et al., *The Deadly Combination of Heat and Humidity in India and Pakistan in Summer* 2015, *in Explaining Extreme Events of 2015 from a Climate Perspective*, Bulletin of the American Meteorological Society 97(12) s81–s86 (Stephanie C. Herring et al. eds. Dec. 2016), https://perma.cc/E4KX-AAYT;

the acute health-related dangers of heat without recourse to artificial means of cooling.[44] In the coming decades, greater spending power combined with growing numbers of hot days in developing countries is expected to drive huge volumes of AC sales.[45] This will, on the one hand, provide greater protection for public health vis-à-vis heat hazards. On the other hand, however, it will potentially drive a large increase in the release of F-gases into the atmosphere. Thus, whereas an aggressive program of climate mitigation might call for restrictions on the use of AC reliant on F-gases in the U.S. and elsewhere, such restrictions would impose significant co-harms on public health in large swathes of the developing world.

A. Co-benefits of mitigation

This part briefly describes two examples of climate change mitigation efforts that would yield significant public health co-benefits. It follows that description with a discussion of the limited and inconsistent ways in which the law recognizes such co-benefits.

1. Reducing fossil fuel use

Material threats to public health have been identified in relation to the air and water pollution resulting from nearly all aspects of getting at and using fossil fuels: coal mining,[46] the "conventional" drilling and exploitation of land-based and off-shore oil deposits[47] and wells

[43] Tom Kosatsky, *The 2003 European Heat Waves*, Eurosurveillance (noting estimate of 22,080 excess deaths amid 2003 heatwaves in Europe); Stephen Whitman et al., *Mortality in Chicago attributed to the July 1995 heat wave*, American Journal of Public Health 87(9) 1515-18 (1997), https://perma.cc/R6SD-VBGE.

[44] Yan Wang et al., *Heat stroke admissions during heat waves in 1,916 US counties for the period from 1999 to 2010 and their effect modifiers*, Environmental Health 15:83 (Aug. 2016) (identifying correlation between access to central AC and lower rates of hospitalization during heat waves).

[45] O. Abdelaziz, W. Goetzler et al., The Future of Air Conditioning for Buildings (July 2016), https://perma.cc/959T-JJKD.

[46] Mountaintop removal mining (MTR) is notoriously polluting of the air and water around the mountains that it transforms into flattened moonscapes; however, a National Academies panel has been convened to resolve ongoing disputes about the public health impacts of that pollution by assessing the quality of existing studies and to identify what research questions remain open. Stephen Lee, Evidence Thin That Mountaintop Mining Harms Health: Coal Groups, BloombergBNA Daily Environment Report, Jul 19, 2017 ("On July 11, a National Academy of Sciences panel heard evidence from researchers broadly connecting mountaintop removal mining to higher rates of heart disease, cardiovascular disease, stroke, and death. . . . However, the researchers who presented their work also repeatedly stressed that the data are still too thin and that more study is needed."); *see also* National Toxicology Program, *Mountaintop Removal Mining: Impacts on Health in the Surrounding Community* (last updated Nov. 16, 2016), http://bit.ly/2tdDESl (for list of studies on adverse public health impacts of MTR in Central Appalachia, follow link to "Included and Excluded Studies (Updated Nov. 16, 2016)" spreadsheet and select "Included (n=37)" tab).

[47] Impacts are especially severe in less developed countries with weaker regulatory regimes. *See* Cristina O'Callaghan-Gordo et al., *Health effects of non-occupational exposure to oil extraction*, Environmental Health 15:56 (2016) , https://perma.cc/WW8Z-U4VR. Impacts of off-shore drilling arise chiefly from spills or occupational exposures. L.C. Peres et al., *The Deepwater Horizon Oil Spill and physical health among adult women in southern Louisiana: the Women and Their Children's Health (WaTCH) study*, 124 Environmental Health Perspectives 1208–1213 (2016), https://perma.cc/X65W-WKUB; Blanca Laffon et al., *Effects of exposure to oil spills on human health: Updated review*, Journal of Toxicology and Environmental Health, Part B 19:105-28 (2016), http://dx.doi.org/10.1080/10937404.2016.1168730; Jo S. Stenehjem et al., *Self-reported Occupational Exposures*

using "unconventional" high volume hydrofracture drilling;[48] gas and oil refining;[49] the transportation of coal via train,[50] and of gas and oil via train,[51] tanker,[52] and pipeline;[53] gas and oil storage;[54] gasoline distribution;[55] and, of course, the combustion of fossil fuels, whether by

Relevant for Cancer among 28,000 Offshore Oil Industry Workers Employed between 1965 and 1999, Journal of Occupational and Environmental Hygiene 12:458-68 (2015), http://dx.doi.org/10.1080/15459624.2014.989358.

[48] Shaina L. Stacy, *A Review of the Human Health Impacts of Unconventional Natural Gas Development*, 4 Current Epidemiology Reports 38–45, (Mar. 2017); Nancy E. Lauer et al., *Brine Spills Associated with Unconventional Oil Development in North Dakota*, Environ. Sci. Technol. 2016, 50, 5389–5397; New York State Department of Health, A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development (Dec. 2014), https://perma.cc/X2KB-XYXQ (describing identified adverse air and water quality impacts, and concluding that there is too much uncertainty about fracking's potential public health impacts to allow it in New York); Maryland Institute for Applied Environmental Health, Potential Public Health Impacts of Natural Gas Development and Production in the Marcellus Shale in Western Maryland 26–83 (July 2014), https://perma.cc/X2KB-XYXQ (listing "community impacts" and "occupational impacts").

[49] Emmanuelle Lavaine & Matthew Neidell, Energy Production and Health Externalities: Evidence from Oil Refinery Strikes in France, 4 Journal of the Association of Environmental and Resource Economists 447-77 (Apr. 2017), https://perma.cc/74R6-78B5; Michael T. Kleinman et al., *Emissions from oil and gas operations in the United States and their air quality implications*, 66 Journal of the Air & Waste Management Association 1165-70 (2016), https://perma.cc/HRW7-5FGP.

[50] Multnomah County Health Department, The Human Health Effects of Rail Transport of Coal Through Multnomah County, Oregon: A Health Analysis and Recommendations for Further Action (Feb. 2013), https://perma.cc/3JAC-Q3AB.

[51] Melissa Genereux et al., *Two years after the train derailment: Lac-Megantic (Quebec, Canada) residents are still suffering*, Eur J Public Health (2016) 26:207-08 (suppl_1), ; Ann Hayward Walker et al., *Consensus Ecological Risk Assessment of Potential Transportation-related Bakken and Dilbit Crude Oil Spills in the Delaware Bay Watershed, USA*, 4 Journal of Marine Science and Engineering 23, tbl. 1 (2016), https://perma.cc/29MG-9GN8 (listing incidents of spills of Bakken or Dilbit crude from railways between 2010 and 2014).

[52] Heon Lee Cheol et al., *Acute Health Effects of the Hebei Oil Spill on the Residents of Taean, Korea*, J Prev Med Public Health. 2010;43(2):166-173, https://perma.cc/GZ3H-8K3U; Gina M. Solomon & Sarah Janssen, *Health Effects of the Gulf Oil Spill,* 304(10) JAMA 1118-19 (Sept. 2010), https://perma.cc/SWN2-W6LM.

[53] Romany M. Webb, Safety First, Environment Last: Improving Regulation of Gas Pipeline Leaks, KBH Center for Energy, Law & Business, Research Paper No. 2015-14 (Sept. 2015), http://bit.ly/2tjmjU8 (noting prevalence of leaks and explosions in aging U.S. gas transmission and distribution infrastructure); Elizabeth Douglass, *Two Years After Exxon's Mayflower Spill, Will Tougher Pipeline Rules Go Beyond Talk?*, InsideClimate News, Mar. 30, 2015, https://perma.cc/SE76-N63S; Ayana R. Anderson, CDC Morbidity and Mortality Weekly Report (MMWR), *Health Effects of Cut Gas Lines and Other Petroleum Product Release Incidents — Seven States, 2010–2012*, June 12, 2015 / 64(22);601-605, https://perma.cc/2LK5-KDRJ.

[54] Nathaniel Rich, *The Invisible Catastrophe*, N.Y.T. Mag., March 31, 2016, https://perma.cc/GG9U-Y22W ("In November, readings taken by SoCalGas near its facility found benzene concentrations fluctuating wildly between 0.3 p.p.b. and a nightmarish 30.6; readings taken by the company in Porter Ranch shot as high as 5.5 p.p.b."); Drew R. Michanowicz et al., A national assessment of underground natural gas storage: identifying wells with designs likely vulnerable to a single-point-of-failure, 12 Environmental Research Letters 064004 (May 2017), https://perma.cc/7G23-NA73.

[55] Markus Hilpert et al., *Hydrocarbon Release During Fuel Storage and Transfer at Gas Stations: Environmental and Health Effects*, Current Environmental Health Reports (Dec. 2015) 2(4) 412–422, https://perma.cc/MG59-YCR5; Vicky Huppé et al., *Residential proximity to gasoline service stations and preterm birth*, 20 Envtl. Sci. & Pollution Res. 7186 (Oct. 2013), doi:10.1007/s11356-013-1677-y.

industrial facilities, for electricity generation, or in vehicles.[56] The mechanisms through which these activities expose people to pollutants are numerous and varied, but generally fall into three categories: pollutants that reduce local or regional air quality;[57] toxic pollutants initially emitted by smokestacks that are deposited in watersheds and from there enter drinking water supplies and food chains;[58] and pollutants introduced directly into surface or subsurface waters.[59]

The practical task of estimating these co-benefits is facilitated by several factors. Legally mandated pollution controls have called into being sophisticated techniques and technologies for tracking pollution levels, and the measurable volumes of—and predictable relationships among—GHG and non-GHG pollutants make it relatively easy to extrapolate the ultimate effects of non-GHG emissions reductions that would follow from GHG emissions reductions.[60] Similarly, the pathways through which non-GHG air pollution burdens public health have been studied extensively.[61] Furthermore, EPA generally estimates the costs and benefits of proposed air quality standards, even when the Clean Air Act directs that such estimates should not inform

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[56] Heidi Vreeland et al., *Oxidative Potential Of PM2.5 During Atlanta Rush Hour: Measurements Of In-Vehicle Dithiothreitol (DTT) Activity*, 165 Atmospheric Environment 169–78 (2017) (in-vehicle PM2.5 samples collected during rush hour exceeded concentrations of particulates measured on roadsides); Frederica P. Perera, *Multiple Threats to Child Health from Fossil Fuel Combustion: Impacts of Air Pollution and Climate Change*, Envtl. Health Perspectives (June 2016), http://dx.doi.org/10.1289/EHP299 ("The data summarized here show that by sharply reducing our dependence on fossil fuels we would achieve highly significant health and economic benefits for our children and their future."); Ryan Wise et al., The Environmental and Public Health Benefits of Achieving High Penetration of Solar Energy in the United States (May 2016), https://perma.cc/94PW-ZSG2; L. Noel & R. McCormack, *A cost benefit analysis of a V2G-capable electric school bus compared to a traditional diesel school bus*, Appl Energy, 126 (2014), pp. 246-255 (estimating public health benefits from lower levels of air pollution.

[57] American Lung Association, State of the Air 2017, at 32-40 (2017) (providing overview of adverse health effects of exposure to particulate matter and ozone); G.F. Nemet et al., *Implications of Incorporating Air-Quality CoBenefits into Climate Change Policymaking*, Environmental Research Letters 5:19 (2010).

[58] https://www.bloomberg.com/news/articles/2017-08-08/coal-plants-might-be-even-more-toxic-than-we-thought; Adeline R. Lopez et al., Coal Ash Constituents at the Base of Aquatic Food Webs: Processes Affecting Bioaccumulation and Trophic Transfer, UNC Water Resources Research Inst. Rep. No. 465 (May 2016) (tracing arsenic from coal-fired power plants through aquatic food chains); EPA, National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial- Commercial- Institutional, and Small Industrial- Commercial-Institutional Steam Generating Units, 77 Fed. Reg. 9304, (Feb. 16, 2012) ("up to 29 percent of modeled watersheds have populations potentially at-risk from exposure to [mercury] from U.S. EGUs.").

[59] William D. Burgos et al., *Watershed-Scale Impacts from Surface Water Disposal of Oil and Gas Wastewater in Western Pennsylvania*, 51 Environ. Sci. Technol. 8851 (2017), (reporting on pollutants introduced into Pennsylvania surface waters after treatment of hydrofracture backflow by treatment facilities); Jennifer S. Harkness et al., *Evidence for Coal Ash Ponds Leaking in the Southeastern United States*, 50 Environ. Sci. Technol. 6583−6592 (2016) https://perma.cc/MM9R-2TCW; Amrika Deonarine et al., *Environmental Impacts of the Tennessee Valley Authority Kingston Coal Ash Spill. 2. Effect of Coal Ash on Methylmercury in Historically Contaminated River Sediments*, 47 Environ. Sci. Technol. 2100−2108 (2013), https://perma.cc/WVS7-Z873.

[60] *See* Justin V. Remais et al., *Estimating the Health Effects of Greenhouse Gas Mitigation Strategies: Addressing Parametric, Model, and Valuation Challenges*, 122 Environ Health Perspect. 447–455 (May 2015).

[61] *See, e.g.*, Philip J. Landrigan, *Air pollution and health*, The Lancet: Public Health 2(1) e4-e5 (Jan. 2017) ("Air pollution is one of the great killers of our age."); Frank J. Kelly & Julia C. Fussell, *Air pollution and public health: emerging hazards and improved understanding of risk*, Environmental Geochemistry & Health. 2015; 37(4): 631–649.

the agency's decision about a particular standard.[62] Of course, debate persists over the nature and extent of adverse public health impacts attributable to some of the activities listed above.[63] Nonetheless, it cannot be gainsaid that public health co-benefits would accrue from the reduced exposures to conventional and toxic pollutants that would follow from reducing the extraction, transportation, and consumption of fossil fuels.[64]

2. Improving agricultural nitrogen use efficiency

To grow, crops need reactive nitrogen, which is naturally scarce (unreactive nitrogen is abundant, but not useful to plants).[65] Historically, the availability of naturally occurring reactive nitrogen was a limiting factor for crop growth;[66] the synthesis of nitrogen fertilizers thus marked a crucial advance in agricultural technology.[67] Demand for synthetic nitrogen fertilizers is now endemic to agriculture,[68] as is the excessive provision of those fertilizers on land under cultivation.[69] Excess reactive nitrogen that is spread on croplands often becomes a pollutant. As nitrate (NO_3) it does the following: contaminates drinking water aquifers and causes acidification, hypoxia (oxygen depletion), as well as the eutrophication that feeds harmful algae blooms in coastal and lake ecosystems.[70] As nitrous oxide (N_2O), it depletes stratospheric ozone[71] and is a potent greenhouse gas—298 times more potent than CO_2.[72] These harmful

[62] *See* Livermore & Revesz, *supra* note 13, at 1188 n.13.

[63] *See, e.g.*, Madelon L. Finkel & Jake Hays, *Environmental and health impacts of 'fracking': why epidemiological studies are necessary*, 70 Journal of Epidemiology and Community Health 221-22 (2016), https://perma.cc/98NF-A82G (observing that existing studies of public health impacts are inconclusive, partly due to the long latency periods of adverse medical outcomes from exposures likely to result from proximity to drilling).

[64] Andy Haines, *Health co-benefits of climate action*, The Lancet Planetary Health 1(1) e4-e5 (Apr. 2017) (collecting and summarizing studies); Fernando Garcia-Menendez et al., *U.S. Air Quality and Health Benefits from Avoided Climate Change under Greenhouse Gas Mitigation*, 49 Environ. Sci. Technol. 7580–7588, 7586 (2015) https://perma.cc/4RE8-BJVB (identifying significant benefits to air quality from the mitigation of climate change even ignoring accompanying reductions in ozone and PM pollution levels). This chapter does not attempt to answer the larger question of whether and under what conditions *net* public health benefits would follow from the reduction and substitution of fossil fuel use. *See* notes 20 & 21, *supra*, and accompanying text.

[65] Unreactive nitrogen (N_2) makes up much of the Earth's atmosphere. Reactive nitrogen takes several forms, including nitrate (NO_3), ammonia (NH3), and nitrous oxide (N_2O).

[66] Vaclav Smil, Enriching the Earth (2004).

[67] *Id.*

[68] *See* UN Food and Agriculture Organization, World fertilizer trends and outlook to 2019: Summary Report 7 (2016), http://www.fao.org/3/a-i5627e.pdf (tabulating world demand for nitrogen fertilizer by region).

[69] Allen G. Good & Perrin H. Beatty, *Fertilizing Nature: A Tragedy of Excess in the Commons*, 9 PLoS Biology e1001124 (Aug. 2011).

[70] Marc Ribaudo et al., USDA Economic Research Service, Nitrogen in Agricultural Systems: Implications for Conservation Policy 1 (Sept. 2011), https://perma.cc/TYD8-U5NS; *see also* E. Sinha et al., *Eutrophication will increase during the 21st century as a result of precipitation changes*, 357 Science 405-08 (July 2017) (describing how climate change will amplify the effects of reactive nitrogen pollution).

[71] *See generally* United Nations Environment Program (UNEP), Drawing Down Nitrous Oxide to Protect the Ozone Layer (2013).

[72] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2015, at ES-3 tbl. ES-1 (2017) (listing GHGs and indicating global warming potentials of each relative to CO_2); *see also* A. R. Ravishankara et al., *Nitrous Oxide*

effects are not de minimis. Excessive use of nitrogen fertilizer is a key cause of the dead zone in the Gulf of Mexico at the mouth of the Mississippi River,[73] and is responsible for roughly $1.7 billion of the $4.8 billion spent annually on removing nitrates from drinking water supplies.[74] "Agricultural soils management," which includes fertilization and manure management, generates 75% of the anthropogenic N_2O emitted by U.S. sources.[75] Furthermore, the greater intensity of precipitation attributable to climate change exacerbates the transmission of nitrogen from agricultural soils.[76] Thus, as reactive nitrogen is a source of multiple forms of harmful pollution, improving its use efficiency (i.e., reducing instances of excessive application) on croplands would yield significant climate change mitigation benefits as well as public health co-benefits, such as drinking water provision.[77]

3. When co-benefits are legally cognizable in the U.S.

Though co-benefits are hugely significant to the economics and public health implications of climate change policy,[78] in the U.S. they are only relevant legally if they appear in the following narrow set of circumstances: a legal challenge to a federal regulation adopted in part because of its co-benefits (or despite its co-harms).[79] This relevance stands on two feet, one administrative, the other legal. The administrative foot is the Executive Order that directs

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(N2O): The Dominant Ozone-Depleting Substance Emitted in the 21st Century, 326 Science 123 (2009). Notably, N_2O is recognized as an ozone-layer-depleting gas under the Vienna Convention, but was not listed in the Montreal Protocol among pollutants to be phased out of use. Vienna Convention for the Protection of the Ozone Layer, Annex I, ¶4(b)(i), Mar. 22, 1985; Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987.

[73] EPA Science Advisory Board, Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options 34–35 (2011), https://perma.cc/7399-63ME.

[74] *Id.* at 4.

[75] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2015, at ES-6 tbl. ES-2 (2017).

[76] Terrance D. Loecke et al., *Weather whiplash in agricultural regions drives deterioration of water quality*, 133 Biogeochemistry 7–15 (Mar. 2017), https://link.springer.com/article/10.1007/s10533-017-0315-z (measuring increases in N resulting from rainfall made more severe by climate change).

[77] David R. Kanter et al., *Managing a forgotten greenhouse gas under existing U.S. law: An interdisciplinary analysis*, 67 Environmental Science and Policy 44, 45 (2017); *see also* USDA ERS (noting that among best management practices available to reduce harmful effects of reactive nitrogen pollution, only improved nitrogen use efficiency reliably redues *all* adverse effects).

[78] *See* Ian Parry et al., *How Much Carbon Pricing Is in Countries' Own Interests? The Critical Role of Co-Benefits*, 6 Climate Change Econ. 1550019 (Nov. 2015); San Francisco Department of Public Health, Assessing the Health Co-benefits of San Francisco's Climate Action Plan (Aug. 2013); J. Jason West et al., *Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health*, 3 Nature Climate Change 885 (2013); Nemet et al., *supra* note __, at 2–3 (noting that air quality co-benefits in particular "are large" but are, as of 2010, largely ignored by climate policy decisionmakers).

[79] *See* Carolyn Cecot & W. Kip Viscusi, *Judicial Review of Agency Benefit-Cost Analysis*, 22 Geo. Mason L. Rev. 575, 576 (2015) (discussing history of agency cost-benefit analysis and noting that "there must be some legal challenge involving the regulation and its BCA to trigger a judicial review."). The sole exception to this statement as of this writing appears to be California's law, AB 1532, adopted in 2012. California Global Warming Solutions Act of 2006: Greenhouse Gas Reduction Fund (2012). That law requires the agencies responsible for making California Climate Investments, (i.e., spending the revenue from the state's greenhouse gas emissions cap-and-trade program), to maximize the co-benefits resulting from those expenditures. California Air Resources Board, Cap-and-Trade Auction Proceeds: Co-benefit Assessment Methods, https://perma.cc/KY8B-WRSU (last updated Oct. 27, 2017).

agencies to only adopt a proposed regulation after analyzing its benefits and its costs.[80] The Office of Management and Budget (OMB), which has more fully prescribed how agencies should conduct a cost-benefit analysis, defines a co-benefit (which it calls an "ancillary benefit") as "a favorable impact of the alternative under consideration [i.e., the rule,] that is typically unrelated or secondary to the purpose of the [rule]."[81] OMB also makes plain that co-benefits are relevant to cost-benefit analysis: agencies are to "look beyond the direct benefits and direct costs of your rulemaking and consider any important ancillary benefits and countervailing risks," and to apply to them "[t]he same standards of information and analysis quality that apply to direct benefits and costs."[82]

The basic legal footing for co-benefits' relevance is the Administrative Procedure Act, as interpreted by federal courts. The Act directs that agency rulemakings should reflect consideration of the factors contemplated by the relevant statute, and courts have read this direction to inform the scope of costs and benefits agencies should consider in the rulemaking process.[83] Several courts have confirmed the relevance of co-benefits to rules' administrative validity and legality.[84] In *U.S. Sugar Corp. v. EPA*, for instance, the D.C. Circuit upheld an EPA regulation after agreeing with EPA that:

> its consideration of these co-benefits [from lowering different Hazardous Air Pollutants (HAPs) than those primarily targeted by the proposed standard] was not a regulation of other pollutants; rather, it was simply choosing not to ignore the purpose of the CAA—to reduce the negative health and environmental effects of HAP emissions—when exercising its discretionary authority under the Act.[85]

[80] Executive Order 12,866 instructs agencies to conduct a cost benefit analysis of any significant proposed regulation and to adopt regulations whose societal benefits exceed their costs. Exec. Order No. 12866, *Regulatory Planning and Review*, 58 Fed. Reg. 51735, (Oct. 4, 1993); *see also* Exec. Order No. 13,563, 76 Fed. Reg. 3821 (Jan. 21, 2011) (affirming Exec. Order No. 12,866). *See also generally* Maeve P. Carey, Congressional Research Service, Cost-Benefit and Other Analysis Requirements in the Rulemaking Process (Dec. 2014), https://perma.cc/23YS-JXSN.

[81] OIRA, OMB, EOB, Regulatory Impact Analysis: A Primer 7 (Aug. 15, 2011), https://perma.cc/5Z6D-FJJP. OMB Circular A-4, which OMB issued in 2003 to "standardiz[e] the way benefits and costs of Federal regulatory actions are measured," OMB Circular A-4, at 1 (2003), 68 Fed. Reg. 58366 (Oct. 9, 2003), offers an example of a valid co-benefit: "e.g., reduced refinery emissions due to more stringent fuel economy standards for light trucks." *Id.* at 26.

[82] OMB Circular A-4, at 26.

[83] Michigan v. EPA, 135 S. Ct. 2699, 2706 (2015) ("agency action is lawful only if it rests 'on a consideration of the relevant factors.' *Motor Vehicle Mfrs. Assn. of United States, Inc. v. State Farm Mut. Automobile Ins. Co.*, 463 U.S. 29, 43.").

[84] *See, e.g.*, Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1198–1203 (9th Cir. 2008) (reversing agency for quantifying only ancillary costs but not ancillary benefits); Am. Trucking Ass'ns v. EPA, 175 F.3d 1027, 1051–52 (D.C. Cir. 1999) (holding that EPA was wrong to disregard some indirect effects of proposed rule), *rev'd on other grounds sub nom.* Whitman v. Am. Trucking Ass'ns, 531 U.S. 457 (2001); Competitive Enter. Inst. v. Nat'l Highway Traffic Safety Admin., 956 F.2d 321, 327 (D.C. Cir. 1992) (remanding fuel economy standard on grounds that agency failed to weigh ancillary costs of lives lost because more people would buy and drive smaller vehicles, which are less protective in accidents).

[85] United States Sugar Corp. v. EPA, 830 F.3d 579, 625 (D.C. Cir.), *reh'g en banc*, 671 F. App'x 822 (D.C. Cir. 2016), *reh'g en banc in part*, 671 F. App'x 824 (D.C. Cir. 2016), *cert. denied sub nom.* Am. Mun. Power v. EPA, No. 16-1168, 2017 WL 1134103 (U.S. June 26, 2017).

Consistent with this reasoning, EPA has also counted as co-benefits: criteria pollutants reduced by the regulation of other criteria pollutants,[86] and criteria pollutants reduced by the regulation of GHGs.[87]

Though they have confirmed co-benefits' administrative and legal relevance, courts have yet to explore the limits of that relevance.[88] Much debate over the judicial interpretation of co-benefits has lately focused on EPA's decision to adopt the Mercury and Air Toxics Standard, which the Supreme Court remanded but did not vacate in *Michigan v. EPA*.[89] EPA estimated $4 to $6 *million* in benefits from the rule's reduction of the harmful effects of mercury on the mental capacity of people exposed to it ("IQ points lost"), $9.6 *billion* in annual costs, and $37 to $90 *billion* in benefits from indirect or ancillary reductions in fine particulate matter ($PM_{2.5}$).[90] Thus direct benefits did not outweigh costs, and roughly 90% of the benefits tallied were co-benefits arising from effects incidental to the emissions targeted by the rule. However, because EPA did not rely on this calculation to justify the rule,[91] the Court did not resolve several questions related to it, such as:

- To what extent should courts defer to agency decisions about the significance of co-benefits to a rule's adoption?[92]
- Should an agency weigh co-benefits that would accrue from reductions of $PM_{2.5}$ below the level embodied in the relevant NAAQS, i.e., the level determined by EPA to be safe?[93]

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[86] EPA, Final Ozone NAAQS Regulatory Impact Analysis 6-30 (Mar. 2008), https://perma.cc/443A-5M3L.

[87] EPA, *Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, 80 Fed. Reg. 64662, 64679 (Oct. 23, 2015); EPA, Regulatory Impact Analysis for the Clean Power Plan Final Rule 4-11 to 4-42 (Aug. 2015), https://perma.cc/4ETS-BFU4, (describing calculation of monetized benefits from $PM_{2.5}$ reduction and non-monetized benefits from reductions of other criteria pollutants).

[88] *See* Cecot & Viscusi, *supra* note _, at 576–77, 592–603 (surveying cases that have addressed validity of agencies different approaches to cost-benefit analyses, e.g., choice of discount rate to be applied to future costs or benefits).

[89] Michigan v. EPA, 135 S. Ct. 2699 (2015) (remanding but not vacating the rule). EPA announced that the rule's requirements would remain in force while it revised the explanation of its legal basis pursuant to the Supreme Court's instructions. The D.C. Circuit rejected industry challenges to this step, White Stallion Energy Center, LLC v. EPA, No. 12-1100 (D.C. Cir. Dec. 15, 2015), and EPA issued that revised explanation in due course. EPA, Supplemental Finding that it is Appropriate and Necessary to Regulate Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units, 81 Fed. Reg. 24419 (Apr. 25, 2016). EPA's Supplemental Finding was immediately challenged by the same industry coalition, and the D.C. Circuit then granted a request by Trump Administration's EPA to hold the case in abeyance and to stay the rule while EPA reviewed the 2016 Supplemental Finding. Murray Energy Corporation v. EPA, No. 16-1127 (D.C. Cir. Apr. 27, 2017).

[90] Michigan v. EPA, 135 S. Ct. at 2706.

[91] *Id.* at 2711. Indeed, the gravamen of the case was whether the Clean Air Act directed EPA to only consider the rule's effects on health or to also consider its cost implications.

[92] *See* Michael Abramowicz, *Toward a Jurisprudence of Cost-Benefit Analysis*, 100 Mich. L. Rev. 1708 (2002) (proposing that courts develop a "common law of cost-benefit analysis" rather than ceding the whole of that analytic field to agencies).

[93] EPA did so in the case of the MATS rule. *See* EPA, *National Emission Standards for Hazardous Air Pollutants from Coal and Oil Fired Electric Utility Generating Units*, 77 Fed. Reg. 9304, 9305 (Feb. 16, 2012); EPA,

- If costs outweigh direct benefits but are outweighed by co-benefits, should the rule be considered beneficial?

The mismatch between the practical and legal relevance of public health co-benefits to climate policy highlights an important gap in regulatory accounting, but one that is difficult to bridge. Perhaps, like the development and implementation of the Social Cost of Carbon, the highly technical task of articulating how best to integrate measures of co-benefits into regulatory decisionmaking is one for a multi-agency working group or the National Academies of Sciences.[94]

B. Co-harms of mitigation

Researchers who have examined the co-harms of mitigation in the developed world, including the U.S., have identified rising costs of energy and food, and employment impacts of the transition away from fossil-fuels as the most likely to be significant.[95] Notably, these are all indirect sources of co-harms—in marked contrast to the more direct sources of co-benefits described above. The three examples of co-harms discussed below highlight how existing laws address—or fail to address—them.

1. Biofuels production and consumption

Biofuels are derived from plants and function as substitutes for liquid fossil fuels, chiefly motor fuels. In the U.S., the federal Renewable Fuel Standard—a purchasing mandate for U.S. motor fuel distributors—drives their production.[96] That production has a host of adverse public health impacts, including air and water pollution.[97] It also boosts food prices, with implications for nutrition and food security both in the U.S. and abroad.[98] In addition, some biofuels'

Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards 5-1 to 5-3 (Dec. 2011), https://perma.cc/6TD2-RDXJ (summarizing health co-benefits calculation).

[94] *Cf.* National Academies of Sciences, Valuing Health for Regulatory Cost-Effectiveness Analysis (2006).

[95] Modeling Toronto's Low Carbon Future—Technical Paper #4: Considerations of Co-benefits and Co-harms Associated with Low Carbon Actions for TransformTO 39 tbl.5 (Jan. 2017) http://taf.ca/wp-content/uploads/2017/02/170127_FINAL_Tech-Paper4_Cobenefits.pdf (higher housing costs due to density; employment impacts from displacement).

[96] Energy Independence and Security Act of 2007, Pub. L. No. 110-140 (2007) (establishing Renewable Fuel Standard 2 (RFS2) for purposes that include energy security and promotion of renewable fuel sources); 40 C.F.R. pt. 80 (codifying RFS2, which distinguishes among fuels based on their lifecycle greenhouse gas emissions levels); *see also* Energy Policy Act of 2005, Pub. L. No. 109-58 (2005) (establishing the initial standard, RFS1, for purpose of enhancing energy security).

[97] S. Kent Hoekman et al., Environmental implications of higher ethanol production and use in the U.S.: A literature review. Part I – Impacts on water, soil, and air quality, Renewable and Sustainable Energy Reviews (2017), http://dx.doi.org/10.1016/j.rser.2017.05.050.

[98] Congressional Budget Office, The Impact of Ethanol Use on Food Prices and Greenhouse-Gas Emissions 8 - 12(2009), (describing effects of RFS on food prices, and the knock-on effect on federal food assistance programs).

consumption has been found to generate higher levels of ozone than the fossil fuels they replace.[99]

It is important to note that biofuels derived from different feed stocks—corn starch, corn stover (i.e., stalks and husks), sugar cane, and switch grass—differ from one another in several important respects, including their lifecycle GHG emissions, production costs and volumes, effects on markets for foodstuffs and livestock feed, and the pollution they generate.[100] Thus different biofuels mitigate climate change better or worse (or not at all) and also yield greater or lesser public health co-harms.[101] Ethanols derived from cornstarch generally perform worst in all respects, apart from being the easiest to produce cost-effectively in large volumes in the U.S.[102]

2. Disuse of fossil fuel extraction, processing, storage, and waste sites and facilities

Large-scale climate change mitigation means the cessation of at least some fossil fuel extraction, transport, refining, storage, and consumption, which in turn means the disuse of a host of facilities where toxic materials are processed and stored. In this way, decarbonization will resemble the historical shift away from other disused energy technologies, such as manufactured gas, which have left toxic legacies behind them.[103] As the fact of Congress' passage of the Surface Mining Reclamation and Control Act (SMCRA), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) make plain, without mandated decommissioning and remediation, disused sites and facilities would in most if not all cases present significant dangers to public health. Thus the shuttering of facilities that currently play important roles in emitting GHGs, if not followed by effective decommissioning and site remediation, can generate co-harms by damaging the surrounding environment on an ongoing basis.

For reasons described more fully in subsection II.B.4 below, the track records for decommissioning and remediation by the coal mining sector (particularly in Appalachia) and

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[99] Noah Scovronick et al., Air Quality and Health Impacts of Future Ethanol Production and Use in São Paulo State, Brazil, 13 Int'l J. Envtl. Res. & Pub. Health 695 (2016); Alberto Salvo & Franz M. Geiger, Reduction in local ozone levels in urban São Paulo due to a shift from ethanol to gasoline use, 7 Nature Geoscience 450 (2014), doi:10.1038/ngeo2144.

[100] EPA, Biofuels and the Environment: First Triennial Report to Congress, Report no. EPA/600/R-10/183F (2011); National Research Council, Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy (2011).

[101] EPA, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis 497 (Feb. 2010) (describing program impacts and noting key differences between fuel types).

[102] For a thorough discussion of the impacts of corn starch ethanol production and the implications of increasing that production, see S. Kent Hoekman et al., *Environmental implications of higher ethanol production and use in the U.S.: A literature review. Part I – Impacts on water, soil, and air quality*, Renewable and Sustainable Energy Reviews (2017), http://dx.doi.org/10.1016/j.rser.2017.05.050; *and* S. Kent Hoekman & Amber Broch, *Environmental implications of higher ethanol production and use in the U.S.: A literature review. Part II – Biodiversity, land use change, GHG emissions, and sustainability*, Renewable and Sustainable Energy Reviews (2017), https://doi.org/10.1016/j.rser.2017.05.052.

[103] *See generally* Allen W. Hatheway, Remediation of Former Manufactured Gas Plants and Other Coal-Tar Sites (2012).

segments of the oil and gas sector suggest that co-harms following mitigation-driven facility closures are a likelihood rather than a mere possibility.

3. Impacts transmitted by local economies and tax bases

Mitigation policies raise the cost of doing business for firms whose profitability relies on it being cheap or costless to emit GHGs.[104] If effective, such policies have net positive effects on public health,[105] but could have net-positive, neutral, or net-negative effects on employment and the economy.[106] Whatever their valence in the aggregate, positive and negative economic effects will not be distributed evenly; some localities will lose.[107] It follows that the public health impacts of raising costs—in some cases prohibitively—on firms with significant exposure to mitigation policies in a given locality, will be mixed and complex. On the one hand, extractive industries, power plants, and high-emitting industrial facilities pollute their surroundings, and some of the jobs they support are unhealthy for the workers doing them.[108] On the other hand, unemployment in the U.S. has been shown to harm public health by leading to higher rates of smoking and drinking,[109] prescription drug use,[110] heart disease,[111] suicide,[112] and all-cause

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[104] *See, e.g.*, Akio Yamazaki, Jobs and Climate Policy: Evidence from British Columbia's Revenue-Neutral Carbon Tax (Dec. 2015) (finding that emissions-intensive industries saw employment declines after imposition of carbon tax).

[105] *See generally* Health and climate change, The Lancet (2009), http://www.thelancet.com/series/health-and-climate-change; *see also* John M. Balbus et al., *A wedge-based approach to estimating health co-benefits of climate change mitigation activities in the United States*, 127 Climatic Change 119–210 (Nov. 2014).

[106] *See* Mita Bhattacharya et al., *The effect of renewable energy consumption on economic growth: Evidence from top 38 countries*, 162 Applied Energy 733 (Jan. 2016) (identifying a positive relationship between renewable energy development and economic growth in numerous countries, and a slightly negative relationship in some others, including the U.S.).

[107] Appalachian Regional Commission, Appalachian Coal Industry, Power Generation and Supply Chain 12 (Mar. 2016), http://bit.ly/2wkZbXJ (showing concentration of job losses in particular counties); *see also* Headwaters Economics, Communities at Risk from Closing Coal Plants (Mar. 2017), https://perma.cc/PVZ9-LNJP. *see also* Transition Stories (2017): http://delta-institute.org/delta/wp-content/uploads/In-Transition-Stories-From-Coal-Plant-Communities-Delta-Institute-Aug-2017.pdf (summarizing statistics and narrative descriptions for numerous U.S. communities in which a coal-fired power plant has closed or is slated for closure).

[108] https://www.bls.gov/iif/oshwc/osh/os/osar0012.htm.

[109] T. Falba et al., The effect of involuntary job loss on smoking intensity and relapse, 100 Addiction 1330–39 (Sept. 2005); S.M. Montgomery et al., Unemployment, cigarette smoking, alcohol consumption and body weight in young British men, 8 Eur. J. Pub. Health 21 (1998).

[110] Daniel Kozman et al., Association between unemployment rates and prescription drug utilization in the United States, 2007–2010, 12 BMC Health Serv Res. 435 (2012).

[111] Stefan Walter et al., The Health Effects of US Unemployment Insurance Policy: Does Income from Unemployment Benefits Prevent Cardiovascular Disease?, 9 PLoS One e101193 (July 2014).

[112] A. Reeves et al., Increase in state suicide rates in the USA during economic recession, 380 Lancet 1813–14 (2012); Timothy J. Classen & Richard A. Dunn, The effect of job loss and unemployment duration on suicide risk in the United States: a new look using mass-layoffs and unemployment duration, 21 Health Econ. 338–50 (Mar. 2012) ("mass layoffs may be powerful localized events where suicide risk increases shortly afterward").

mortality.[113] Importantly, the mechanisms that would link these results to mitigation policies are complex, difficult to parse, and often involve not just downsizing employers but also community institutions confronted with falling local spending and taxes (severance, sales, and property).[114]

4. Existing legal responses to co-harms

As explained below, existing legal responses to the co-harms described above suffer from important shortcomings.

Biofuels. Various laws address some—but only some—of the co-harms of biofuels' production and consumption. Air and water pollution control laws treat the farming and processing of biofuels much like other forms of farming and feedstock processing, requiring that qualifying facilities receive permits to operate and abide by those permits' requirements.[115] Of course, these laws' treatment of agricultural activities is notoriously permissive,[116] and biofuels production and processing fit within many of the same carve-outs that account for that permissiveness. Similarly, the 2017–2025 Corporate Average Fuel Economy standards that govern emissions from passenger vehicles do not make any special provision to address harms arising from ethanol as opposed to standard gasoline.[117] The legislation imposing the Renewable Fuel Standard on fuel distributors does not expressly contemplate co-harms, much less address them, whether they result from pollution, land use changes, or upward pressure on food prices.[118]

[113] David J. Roelfs et al., Losing Life and Livelihood: A Systematic Review and Meta-Analysis of Unemployment and All-Cause Mortality, 72 Social Sci. Med. 840–854 (Mar. 2011); see also Christopher B. McLeod et al., Unemployment and Mortality: A Comparative Study of Germany and the United States, 102 Am. J. Pub. Health 1542–1550 (Aug. 2012) (finding that unemployment leads to mortality increases among low- and medium-skilled Americans, but not Germans of similar job skill levels).

[114] Brian Dabson et al., Case Studies of Wealth Creation and Rural-Urban Linkages 41–42 (Apr. 2012), https://perma.cc/H69Y-JDHN (noting how transition away from extractive industry crunches funding for local government services, including those supportive of public health); *see also* Saqib Rahim, *N.Y.'s steely coal towns brace for transition*, E&E News, Apr. 18, 2017, https://perma.cc/CS4Y-HK4H (reporting impending loss of $6 million in annual taxes paid to the local government).

[115] *See* EPA Region 7, Environmental Laws Applicable to Construction and Operation of Ethanol Plants (Nov. 2007), https://perma.cc/LL6D-G9K8.

[116] J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 Ecology L.Q. 263, 263–64 (2000) ("Farms are one of the last uncharted frontiers of environmental regulation in the United States. Despite the substantial environmental harms they cause . . . environmental law has given them a virtual license to do so.").

[117] Incentives for ethanol use embedding in the 2012–2016 CAFE standards were discontinued in the 2017–2025 standards. The only special treatment of note under the new standards is extra credits toward CAFE compliance for manufacturers of flex-fuel vehicles (i.e., those capable of running on mixtures of 85% ethanol and 15% gasoline) *if* those manufacturers can provide evidence of actual vehicle miles travelled using ethanol. EPA & NHTSA, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule, 77 Fed. Reg. 62,624, 62,823–24 (Oct. 15, 2012).

[118] EPA, in compliance with the administrative requirements discussed in part II.A.3, estimates price changes expected to result from federal Renewable Fuel Standard's purchasing mandate and production targets. *See* EPA, Regulatory Impact Analysis: Renewable Fuel Standard Program 325–32 (Apr. 2007), https://www.epa.gov/sites/production/files/2015-08/documents/420r07004.pdf. It does nothing to address those price changes, however.

Remediation. Several laws—chiefly SMCRA, RCRA, and CERCLA—direct firms to conduct decommissioning and remediation of fossil fuel-related facilities and sites, provide agencies and citizens with causes of action against instances of harmful nonfeasance, and make state and federal agencies a partial backstop to nonfeasance. Thus coal mines, gas and oil wells, pipelines, oil refineries, and even gas stations, among other things, cannot simply be abandoned, but must be dealt with in a way that protects public health by preventing the release of any toxic substances onsite and in some instances restoring their location to something like its original state.[119] However, even though these laws provide for minimal amounts of bonding (i.e., the setting aside of funds) or retroactive liability to incentivize thorough cleanup of a site, underinvestment in decommissioning and site remediation is endemic in segments of the energy sector.[120] In relation to coal, this seems to owe to financial pressure on mining operations in the eastern U.S.,[121] and to the unwillingness of state governments and the federal Office of Surface Mining and Reclamation Enforcement to compel more aggressive saving for remediation.[122] In the production and distribution portions of oil and gas sector, the story is similar in some ways,[123] but different in others. While adequate maintenance of a facility or drilling site with healthy financial prospects is a sound investment for a well-capitalized company, such companies often sell when facilities' profitability begins to fade—and generally sell to less well-capitalized buyers with incentives to wring out whatever profitability remains. This wringing out

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[119] *See, e.g.*, SMCRA §§ 508 (requiring all permit applications to include reclamation plan for restoration of mined land to its "pre-mining capability") 509(c) (requiring purchase of reclamation bonds); 42 U.S.C. § 6991b(d) (codifying RCRA provisions relating to underground storage tank remediation financing), CERCLA § 121(d)(1) (defining standard for site cleanup as "at a minimum which assures protection of human health and the environment").

[120] *See, e.g.*, Zachary C.M. Arnold, *Preventing Industrial Disasters in a Time of Climate Change: A Call for Financial Assurance Mandates*, 41 Harv. Envtl. L. Rev. 243, 268–70 (2017) (describing weaknesses in RCRA financial assurance mechanism for underground storage tanks as applied in some but not all states); Jayni Foley Hein et al., Self-Bonding in an Era of Coal Bankruptcy: Recommendations for Reform (Aug. 2016) ("outstanding self-bond obligations currently total $3.86 billion nationwide, of which $2.4 billion is held by coal companies currently in bankruptcy."); Lucas Davis, Modernizing Bonding Requirements for Natural Gas Producers (June 2012) ("Minimum bond amounts were set in 1960 and have never been updated for inflation.").

[121] That pressure was the result of several factors, Susan F. Tierney, The U.S. Coal Industry: Challenging Transitions in the 21st Century, at ES-1 & -2 (Sept. 2016) (listing factors), competition from natural gas in the electricity sector high among them. DOE, Staff Report to the Secretary on Electricity Markets and Reliability 13 (Aug. 2017), https://perma.cc/3J2H-S6LT ("The biggest contributor to coal and nuclear plant retirements has been the advantaged economics of natural gas-fired generation.").

[122] Tripp Baltz et al., *No Collateral Needed for Cleanup in Some States Despite Mine Bankruptcies*, Bloomberg BNA, Mar. 30, 2017, https://perma.cc/6VT9-ZYG4 ("Several states are still willing to let mines operate without putting up collateral for land cleanup even though three of the country's biggest coal companies only recently emerged from bankruptcy."); *see also* Eric L. Dixon & Kendall Bilbrey, Abandoned Mine Land Program: A Policy Analysis for Central Appalachia and the Nation 73 fig.5.2 (July 2015), https://perma.cc/63MK-5UQ5 (showing steep and secular decline of fees collected for remediating abandoned coal mines in Appalachian states; adjusting for inflation, in 2013, collected fees were less than 25% of those collected in 1979).

[123] Jacqueline Ho et al., Resources for the Future, Plugging the Gaps in Inactive Well Policy (May 2016), https://perma.cc/3J7T-54SZ (noting that decommissioning costs generally far exceed bonding requirements in surveyed states).

involves investing less in maintenance and set-asides for eventual decommissioning and environmental remediation.[124]

Mitigation can be expected to increase the number of facilities implicated by these laws, which provide fragmentary coverage,[125] and are often too weak or too easily avoided to ensure adequate investment or action on the part of private parties.[126] Furthermore, the agencies that are meant to provide a backstop are often overwhelmed and unable to make up for private nonfeasance.[127] Thus the environmental and public health consequences of underfunded decommissioning and remediation represent externalities that existing law and policy have failed to price into the cost of doing business in the fossil fuel industry.

Local economic impacts. Existing legal responses to this category of co-harms all fit into the category of programs devised to support a "just transition"[128]—a term coined by unions in the 1980s and applied since to various policy-driven displacements of industry, whether rooted in trade, environmental protection, or something else.[129] These responses tend to be ad hoc, temporary, and reflective of the political circumstances that prevailed at the time of their formulation.

One fairly recent example of a federal response to regional economic impacts that were not driven by mitigation policies, but by policies that resemble mitigation policies, is the Secure Rural Schools and Community Self-Determination Act of 2000 (SRS Act).[130] The SRS Act addressed the economic impacts of the timber industry's decline in localities that, because of

[124] *See* Keith Goldberg, *5 Legal Battles To Watch As Oil, Gas Bankruptcies Surge*, Law360, Mar. 17, 2016, https://perma.cc/N35Y-EUBQ (describing fights over environmental liabilities incurred or held by bankrupt drilling firms).

[125] *See, e.g.*, Stephen Lee, *Mountains of Slag Spur Unlikely Alliance to Clean Up Waste*, BloombergBNA Daily Environment Report, July 25, 2017 ("'If the nation's 18 remaining refuse plants also shut down, the 800 coal refuse piles scattered throughout Pennsylvania—to say nothing of the hundreds more in West Virginia, Kentucky, and other Appalachian states—will remain in place indefinitely, because neither the federal government nor the states have the money to clean them up,' said John Stefanko, deputy secretary for the Office of Active and Abandoned Mine Operations at the Pennsylvania DEP.").

[126] *See, e.g.*, Sylvia Carignan, *Superfund Skepticism Spurs States to Seek Toxic Cleanup Alternatives*, Bloomberg BNA Daily Environment Report, Sept. 18, 2017.

[127] *See* EPA, Hazardous Waste: Baselines for Resource Conservation and Recovery Act (RCRA) Corrective Action Sites, https://perma.cc/Y2MK-3JP4 (last updated Dec. 28, 2016) (providing links to document listing 3,779 sites prioritized by EPA for cleanup pursuant to RCRA); Rachael Bale, *The surprising reason abandoned US mines haven't been cleaned up*, Reveal-The Center for Investigative Reporting, Nov. 4, 2014, https://perma.cc/7TYB-2ETC (reporting that at 500,000 mines remain un-remediated in the U.S.).

[128] *See, e.g.*, Robert Pollin & Brian Callaci, *A Just Transition for U.S. Fossil Fuel Industry Workers*, American Prospect, July 6, 2016, https://perma.cc/6V2J-YRU6 (proposing national program to accompany decarbonization driven by federal policy).

[129] Samantha Smith, Just Transition: A Report for the OECD (May 2017), https://perma.cc/Q6RJ-JFXR (summarizing history of transition policy category and providing examples of transition policies from several international contexts).

[130] Pub. L. No. 106-393, *codified at* 16 U.S.C. §§7101–7153.

their location on or near federal lands, were prohibited from using taxation to raise revenues.[131] Since 1908, they relied instead on a portion of the receipts from federal timber leases—revenues that fell alongside timber sales in the 1990s when the industry shrank and in some places collapsed.[132] The SRS Act originally scheduled its last payments for FY 2006, but that end date was extended a further seven years through several reauthorizations.[133] An earlier example, the Clean Air Employment Transition Assistance Program, was enacted as part of the Clean Air Act Amendments of 1990 with the express purpose of ameliorating those Amendments' impacts on employment in affected sectors.[134] Both of these were straightforward in their logic and focused in their aims: federal money would, for a limited period, offset local economic impacts that federal policy had created in whole or in part by.

A more recent example of a federal transition program included two components: the POWER (Partnerships for Opportunity and Workforce and Economic Revitalization) Initiative, launched in 2015, and the Assistance for Coal Communities (ACC) 2017 program (collectively, the Initiative). Legal authority for the Initiative roots primarily in the 1965 law, amended in 1975, 1998, and 2002, that established the Appalachian Development Commission,[135] but it draws from a variety of sources with diverse statutory bases for funding,[136] and directs that funding to the support of diverse activities.[137] In contrast to the SRS Act and Clean Air Employment Transition Program, the Initiative was not conceived of or codified by Congress, but by the Obama Administration to address existing consequences of coal communities' decline.[138] It was intended to address *anticipated* consequences—actual or perceived—of the Clean Power Plan,[139] whose opponents framed it as the latest attack in the "war on coal," and one

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[131] Katie Hoover, Reauthorizing the Secure Rural Schools and Community Self-Determination Act of 2000 (Mar. 2015), https://perma.cc/U5GV-W65B.

[132] *See* Bruce Sorte et al., Economic Impacts on Oregon Counties of the Termination of the Secure Rural Schools and Community Self-Determination Act (P.L. 106-393) (Dec. 2008), https://perma.cc/9V78-6QJJ (estimating impacts of Act's impending sunset in 2008).

[133] *Id.*

[134] 29 U.S.C. § 1662e ("For purposes of this section, the term ''eligible individual'' means an individual who—(A) is an eligible dislocated worker . . . , and (B) has been terminated or laid off, or has received a notice of termination or lay off, as a consequence of compliance with the Clean Air Act.").

[135] Appalachian Regional Development Act (ARDA) of 1965, *as amended* (codified at 40 U.S.C. § 14101–704.

[136] *See* White House, Fact Sheet: The Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative (Mar. 27, 2015), https://perma.cc/H86P-CFPC ("The POWER initiative will coordinate use of appropriated FY 2015 funds from a range of federal programs, while following the relevant statutory and regulatory requirements for each program."); Consolidated Appropriations Act of 2017, Pub. L. No. 115-31 (including funds for ACC 2017).

[137] Appalachian Regional Commission, POWER Award Summaries by State (Jan. 2017), https://www.arc.gov/images/grantsandfunding/POWER2017/ARCPOWERAwardSummariesbyState1-25-2017.pdf.

[138] Appalachian Citizens' Law Center, *POWER+ For the People*, https://perma.cc/HQJ2-UWX4 (accessed Sept. 28, 2017) ("The 'POWER Initiative' is a federal initiative that provides funding to assist communities struggling with the decline of the coal industry in strengthening and diversifying their economies.").

[139] 80 Fed. Reg. 64,661, 64,676 (Oct. 23, 2015) ("In the final rule, the EPA encourages states, in designing their state plans, to consider the effects of their plans on employment and overall economic development to assure that

that could cause the Appalachian coal supply chain to collapse.[140] Thus the Initiative was, arguably, the first example of a deliberate (if not explicit) federal response to co-harms of climate change mitigation policy in the U.S.

III. Recommendations

The following recommendations are ambitious. That ambition should not mark them as "academic" (i.e., logically sound but actually infeasible). Rather, it should highlight the large size of the gap that separates our current legal regime from one that would translate current scientific understanding of climate change and public health outcomes into limitations on polluting activity and the prudent selection and calibration of climate change mitigation measures.

Adopt legislation clarifying the relevance of climate change to permits issued under environmental laws. Debates over whether and how Congress should address climate change have focused almost exclusively on mitigation measures that would address GHG emissions; adaptation has largely been ignored. As described above, patterns of enforcement of environmental laws will signal that the climate is changing and that adaptation is necessary to protect public health, but that signal is likely to be compromised and also accompanied by a great deal of noise. Congress should ensure that the signal is unmistakeably clear. It can do so by amending key provisions of several statutes—at a minimum, RCRA, CERCLA, and the Clean Water Act—to condition permitting, whether for facilities or whole states, on the conduct of a climate change vulnerability assessment within the past five to 10 years and demonstrated efforts to address any significant vulnerabilities it identifies. For coastal facilities, key vulnerabilities would presumably arise from storms and flooding; for, say statewide water pollution permits under the Clean Water Act, they could arise equally from risks of drought or extreme precipitation.

Fund a study to develop recommendations for the analysis of ancillary effects of regulations with an eye to potential judicial review. Much divides the disparate views of those who dispute how agencies should assess co-benefits and co-harms of a proposed regulation—and how courts should review an agency's assessment. Because these issues are both important and contested, it would be valuable to develop basic points of agreement and to articulate points of disagreement with precision so that further research is more likely to resolve them. The National Academies of Sciences and the U.S. Judicial Conference are both potential sources of neutral expertise that could contribute authors and editors to such an effort.

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the opportunities for economic growth and jobs that the plans offer are manifest. We also identify federal programs, including the multi-agency Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative.").

[140] *See* Lydia Wheeler, *Mining group asks EPA to stay its climate rule*, The Hill, Aug. 3, 2015, https://perma.cc/L484-JDZ3 ("Since more than 90 percent of coal sold in the U.S. is used for power generation, the NMA said the EPA rule would also cripple domestic coal production and eliminate thousands of mining jobs.").

Compel insurance coverage for community public health impacts as well as bonding for site remediation. Planning and prudent investment can avoid many of the public health co-harms that arise from economic transition. Many of those co-harms are avoidable through anticipatory bonding or investment. Firms that are responsible for facilities/sites that will require decommissioning/remediation should prevent local communities from enduring the public health impacts that would arise directly from their abandonment. In addition to bonding requirements, therefore, firms should also be required to carry an insurance policy against direct adverse public health impacts of potential abandonment (i.e., not including indirect effects like unemployment or economic straits). The premiums charged for the policy would reflect the insurer's assessment of the adequacy of money set aside for bonding—adequate bonding would mean a nominal premium, inadequate bonding a potentially enormous premium.

Conclusion

Existing environmental laws are not well suited to addressing the public health impacts of climate change or the impacts of efforts to mitigate it. As this chapter has explained, even laws that make public health their lodestar cannot be expected to reveal fully the costs of climate change or to compel action that effectively addresses or avoids those costs. With respect to mitigation, existing law has thus far failed to take account of the public health impacts of several sources of GHG emissions, and is unlikely to anticipate or avert the impacts of mitigating those emissions. This bleak assessment is the basis for several ambitious recommendations that would not provide complete solutions to the problems identified herein, but would provide important foundations on which to build toward effective solutions.