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Environmental Injustice and the Pursuit of a Post-Carbon World

THE UNINTENDED CONSEQUENCES OF THE CLEAN AIR ACT AS A CAUTIONARY TALE FOR SOLAR ENERGY DEVELOPMENT

Shannon Elizabeth Bell[†]

INTRODUCTION

The combustion of fossil fuels (coal, oil, and gas) and, to a lesser extent, changes in land cover, have led to a rise in greenhouse gasses (GHG) in the atmosphere and an increase in global average surface temperatures.¹ This human-induced warming is causing dramatic changes in the climate that are manifesting in numerous ways throughout the world, including an intensification of storms, rising sea levels, ocean acidification, salt-water intrusion of fresh-water aquifers, more frequent and extreme floods, droughts, and heat waves, changes in the range and occurrence of certain infectious diseases, declines in agricultural productivity, and social upheaval resulting from competition for scarce resources.² Arguably, the transition to a post-carbon³ world is urgent, but thus far little progress has been

[†] Associate Professor of Sociology and Environmental Studies, University of Kentucky, Lexington, KY. I wish to thank Gregg Macey for the invitation to be part of the 2016 Trager Symposium at Brooklyn Law School and to the other Symposium participants for the insightful dialogue and feedback during the event.

¹ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 37 (2007), https://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_synr.pdf [<https://perma.cc/3A2A-JDHN>].

² AAAS CLIMATE SCI. PANEL, WHAT WE KNOW: THE REALITY, RISKS, AND RESPONSE TO CLIMATE CHANGE 1–11, http://whatweknow.aaas.org/wp-content/uploads/2014/07/whatweknow_website.pdf [<https://perma.cc/Y73B-EMWQ>]; Wei Mei et al., *Northwestern Pacific Typhoon Intensity Controlled by Changes in Ocean Temperatures*, 1 SCI. ADVANCES 1, 1 (2015); Kevin E. Trenberth et al., *Attribution of Climate Extreme Events*, 5 NATURE CLIMATE CHANGE 725, 725 (2015).

³ The term “post-carbon” is used to denote a transition away from burning fossil fuels for energy. Daniel Lerch, program director at the Post Carbon Institute,

made toward curbing carbon emissions in the United States and globally.⁴ Even the recent Paris Accord—which was lauded as a “historic breakthrough” and “landmark” climate deal⁵—falls far short of what many scientists argue is needed to limit the rise in global temperatures to a safe level. While the Paris Negotiations yielded an agreement to hold “the increase in the global average temperature to well below 2 °C above pre-industrial levels” and to “pursu[e] efforts to limit the temperature increase to 1.5 °C,”⁶ the emission cuts in the agreement are *voluntary pledges* made by governments and do not actually come close to achieving the 1.5-degree, or even the 2-degree, goal.⁷

The limited outcomes of the Paris Accord should not indicate a lack of grassroots support for effective international policy aimed at addressing climate change, however. On the eve of the Paris Negotiations, over 750,000 people from more than 175 countries took to the streets in what was collectively called the Global Climate March.⁸ Their message to world leaders was a demand to leave “fossil fuels in the ground and [to] finance a just transition to 100% renewable energy by 2050.”⁹ Protests have continued since the Paris Negotiations, such as the “Break Free” demonstrations organized by 350.org during May 2016 that again urged leaders across the world to “break free” from fossil fuels and

defines post-carbon as “no longer using hydrocarbon fuels [i.e. fossil fuels] and no longer emitting climate-changing levels of carbon into the atmosphere” Daniel Lerch, *Preface to THE POST CARBON READER: MANAGING THE 21ST CENTURY’S SUSTAINABILITY CRISES*, at xix, xxiii (Richard Heinberg & Daniel Lerch eds., 2010).

⁴ See HANS-WERNER SINN, *THE GREEN PARADOX: A SUPPLY-SIDE APPROACH TO GLOBAL WARMING* 12–13 (2012); *Climate Change Indicators: Global Greenhouse Gas Emissions* fig.3, EPA, <https://www.epa.gov/climate-indicators/climate-change-indicators-global-greenhouse-gas-emissions> (follow “Figure 3. Global Carbon Dioxide Emissions by Region, 1990–2012” hyperlink) (last updated Dec. 17, 2016); AAAS CLIMATE SCI. PANEL, *supra* note 2, at 6.

⁵ Coral Davenport, *Nations Approve Landmark Climate Accord in Paris*, N.Y. TIMES (Dec. 12, 2015), http://www.nytimes.com/2015/12/13/world/europe/climate-change-accord-paris.html?_r=0 [<https://perma.cc/S6B5-DFX9>].

⁶ U.N. Framework Convention on Climate Change, Conference of the Parties, *Adoption of the Paris Agreement* 1, 2 (Dec. 12, 2015).

⁷ Justin Gillis, *Paris Climate Talks Avoid Scientists’ Idea of ‘Carbon Budget’*, N.Y. TIMES (Nov. 28, 2015), http://www.nytimes.com/2015/11/29/science/earth/paris-climate-talks-avoid-scientists-goal-of-carbon-budget.html?_r=0 [<https://perma.cc/E42H-HRFJ>]. As a recent report by the former chair of the Intergovernmental Panel on Climate Change and other distinguished climate scientists from around the world reveals, even if all nations’ voluntary pledges are achieved, in 2030 global GHG emissions will be 33% higher than is needed to stay below 2° Celsius above pre-industrial levels. ROBERT WATSON ET AL., *THE TRUTH ABOUT CLIMATE CHANGE* 1, 4 (2015), <http://feu-us.org/wp-content/uploads/2016/09/The-Truth-About-Climate-Change.pdf> [<https://perma.cc/729G-CDJ6>].

⁸ *Global Climate March Paris 2015 We Sent a Message to Paris*, 350.ORG, <http://350.org/global-climate-march/> [<https://perma.cc/R2XC-VERK>].

⁹ *Id.*

to make a shift to one hundred percent renewable energy.¹⁰ But what does that transition look like? Many argue that well-designed environmental regulations have the potential to engender technological innovation.¹¹ But can technological fixes really provide a sustainable future for *all* of us?

Where technological fixes often fall short is a lack of attention to the unintended consequences—and unintended casualties—of “environmental sustainability.” As Professor of Urban and Environmental Policy and Planning Julian Agyeman argues, there is an “equity deficit” in most of the discourse and practice of environmental sustainability, as most sustainability policy decisions and environmental regulations have been conceived and implemented without attention to issues of environmental justice.¹² Agyeman et al. maintain that “[s]ustainability . . . cannot be simply a ‘green,’ or ‘environmental’ concern,” rather, “[a] truly sustainable society is one where wider questions of social needs and welfare, and economic opportunity, are integrally related to environmental limits imposed by supporting ecosystems.”¹³ Likewise, sustainability cannot mean that pollution or waste is simply displaced so that one group can enjoy the benefits of a clean and healthy environment at the expense of another group.¹⁴ The reality is, however, that such displacement of harm is the norm.¹⁵ Throughout the world, those

¹⁰ May 3–15, 2016: *On Six Continents, Thousands of People Took Bold Action to Break Free from Fossil Fuels*, BREAK FREE 2016, <https://breakfree2016.org/> [<https://perma.cc/5GKK-E4ES>].

¹¹ Proponents of the “Porter Hypothesis” maintain that well-designed environmental regulation encourages businesses to innovate and enhances competitiveness, pushing the rapid and effective development and deployment of sustainable technology. See STEFAN AMBEC ET AL., RES. FOR THE FUTURE, THE PORTER HYPOTHESIS AT 20: CAN ENVIRONMENTAL REGULATION ENHANCE INNOVATION AND COMPETITIVENESS? 2–5 (2011), <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-11-01.pdf> [<https://perma.cc/AA8X-WWRZ>].

¹² JULIAN AGYEMAN, SUSTAINABLE COMMUNITIES AND THE CHALLENGE OF ENVIRONMENTAL JUSTICE 44 (2005). According to the U.S. EPA, “Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.” *Environmental Justice*, EPA, <https://www.epa.gov/environmentaljustice> [<https://perma.cc/QPJ9-PD24>]. Furthermore, environmental justice is achieved “when everyone enjoys: the same degree of protection from environmental health hazards, and equal access to the decision-making process to have a healthy environment in which to live, learn, and work.” *Id.*

¹³ Julian Agyeman et al., *Exploring the Nexus: Bringing Together Sustainability, Environmental Justice and Equity*, 6 SPACE & POLITY 77, 78 (2002).

¹⁴ *Id.*

¹⁵ See JUST SUSTAINABILITIES: DEVELOPMENT IN AN UNEQUAL WORLD 4 (Julian Agyeman et al. eds., 2003).

with the least political and economic power are “selectively victimized”¹⁶ to bear a disproportionate share of the waste, pollution, and hazards created by society, while the more privileged “quarantine”¹⁷ themselves from environmental pollutants. Most often it is communities of color, low-income communities, indigenous groups, and people living in Global South nations who shoulder the brunt of environmental hazards and pollution.¹⁸

Climate change is a disastrous environmental problem that is caused by the same social forces that are simultaneously leading to other environmental calamities, such as biodiversity loss¹⁹ and environmental health hazards from toxic pollutants in the air, water, and land.²⁰ Insofar as so many of these environmental issues are linked, examining the unintended consequences of past environmental policy decisions—policies that did not give adequate attention to environmental justice—can provide important lessons for decision making aimed at addressing climate change. This article uses the case of the Clean Air Act and its amendments as an example of a policy that has had serious environmental justice consequences.

¹⁶ *Id.*

¹⁷ ANDREW SZASZ, SHOPPING OUR WAY TO SAFETY: HOW WE CHANGED FROM PROTECTING THE ENVIRONMENT TO PROTECTING OURSELVES 4–6 (2007).

¹⁸ ROBERT D. BULLARD, DUMPING IN DIXIE: RACE, CLASS, AND ENVIRONMENTAL QUALITY 98–104 (2d ed. 1994); Robert D. Bullard et al., *Toxic Wastes and Race at Twenty: Why Race Still Matters After All of These Years*, 38 LEWIS & CLARK ENVTL. L.J. 371, 372–74 (2008); Robert D. Bullard, *Race and Environmental Justice in the United States*, 18 YALE J. INT’L L. 319, 319 (1993); Marianne Lavelle & Marcia Coyle, *Unequal Protection: The Racial Divide in Environmental Law a Special Investigation*, NAT’L L.J., Sept. 21, 1992, at S2; DAVID NAGUIB PELLOW, GARBAGE WARS: THE STRUGGLE FOR ENVIRONMENTAL JUSTICE IN CHICAGO 8–11 (2004); DAVID NAGUIB PELLOW, RESISTING GLOBAL TOXICS: TRANSNATIONAL MOVEMENTS FOR ENVIRONMENTAL JUSTICE 8–14, 191 (2007); DORCETA E. TAYLOR, TOXIC COMMUNITIES; ENVIRONMENTAL RACISM, INDUSTRIAL POLLUTION, AND RESIDENTIAL MOBILITY 49, 52–54 (2014).

¹⁹ *Biodiversity* “refers to the variety of life on Earth at all its levels,” including microorganisms, plants, animals, and ecosystems. *What Is Biodiversity?*, AM. MUSEUM OF NAT. HISTORY, <http://www.amnh.org/explore/curriculum-collections/biodiversity-counts/what-is-biodiversity> [https://perma.cc/S9J9-H4CS]. *Biodiversity loss* refers to the loss of this “variety of life,” from individual genes to the extinction of species. See Bradley J. Cardinale et al., *Biodiversity Loss and Its Impact on Humanity*, 486 NATURE 59, 60 (2012) (defining biodiversity as “the variety of life”). Biodiversity loss has impacts on human health and well-being through affecting patterns of infectious diseases, world food production, freshwater supplies, air quality, plant-based medicines, and other ecosystem services. WORLD HEALTH ORG. & SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, CONNECTING GLOBAL PRIORITIES: BIODIVERSITY AND HUMAN HEALTH: A STATE OF KNOWLEDGE REVIEW 1, 3–4, 10, 184, 227 (2015), http://apps.who.int/iris/bitstream/10665/174012/1/9789241508537_eng.pdf [https://perma.cc/PG4X-6N2S].

²⁰ Eugene A. Rosa et al., *The Human (Anthropogenic) Driving Forces of Global Climate Change*, in CLIMATE CHANGE AND SOCIETY: SOCIOLOGICAL PERSPECTIVES 32–60, 33 (Riley E. Dunlap & Robert J. Brulle eds., 2015).

Part I begins with an overview of the Clean Air Act (CAA or Act) and its amendments. Part II then describes the unintended environmental health and safety consequences of the CAA and its amendments for the coal-mining region of Central Appalachia, an area that has suffered a long history of environmental injustices from extractive industries, such as coal, oil, and gas. Section A focuses on the proliferation of coal preparation plants for washing and crushing coal in the post-CAA years and illustrates the negative consequences for nearby communities through excerpts from in-depth interviews conducted with residents living in coalfield communities. Section B shifts to a discussion of coal-fired power plants and the increased toxicity of coal combustion waste after the installation of pollution-removing technology (“scrubbers”). Finally, Part III examines the growth of the solar industry in the U.S., driven in large part by renewable portfolio standards (RPSs), which are state-level policies that mandate utility companies to generate a certain amount of their electricity from renewables, notably solar. Although such policies are commendable in their intent to increase renewable energy production and decrease the use of fossil fuels, there may be negative unintended consequences of these RPS policies, particularly given the lack of mandatory recycling programs to deal with the hazardous waste stream that will be generated once solar photovoltaic panels surpass their usable lifespan. Ultimately, this article argues that society should consider the negative effects of the Clean Air Act and its amendments as a cautionary tale for what can happen when environmental regulations are implemented without accounting for environmental justice concerns.

I. THE CLEAN AIR ACT AND ITS AMENDMENTS

The Clean Air Act was passed to protect citizens from air pollution generated by a variety of sources such as vehicles, power plants, and other industrial facilities.²¹ The Act mandates that the Environmental Protection Agency (EPA) establish and regularly revise national ambient air quality standards for six common pollutants: particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. The Act also provides EPA with the authority to add other pollutants

²¹ EPA, *THE CLEAN AIR ACT IN A NUTSHELL: HOW IT WORKS 1* (2013), https://www.epa.gov/sites/production/files/2015-05/documents/caa_nutshell.pdf [<https://perma.cc/AT49-CQBU>].

to this list.²² One of the main pollutants the CAA regulates is sulfur dioxide (SO₂), which is emitted when coal is burned,²³ and, along with nitrogen oxides (NO_x), creates acid rain, which causes widespread damage to aquatic and forest ecosystems.²⁴ Furthermore, sulfur dioxide and nitrogen oxides cause damage to human health.²⁵ Although the amendments to the CAA introduced in 1970, 1977, and 1990 all sought to decrease SO₂ emissions from coal-fired power plants,²⁶ the 1990 Amendments were by far the most stringent. A primary mandate of the 1990 Amendments was a reduction in annual SO₂ emissions to ten million tons below the 1980 emissions level and a reduction in nitrogen oxides emissions to two million tons below the 1980 emissions level.²⁷ While the 1977 CAA Amendments had incentivized installing scrubbers to reduce sulfur emissions, the 1990 Amendments allowed more flexibility in reaching the stricter emissions standards.²⁸ Most existing coal-fired power plants chose to meet the new standards by seeking out low-sulfur coal rather than by retrofitting expensive sulfur-dioxide-reducing

²² *Id.* at 3.

²³ See David W. Hercher, *New Source Performance Standards for Coal-Fired Electric Power Plants*, 8 *ECOLOGY L.Q.* 748, 748–49 (1980).

²⁴ *Effects of Acid Rain*, EPA, <https://www.epa.gov/acidrain/effects-acid-rain> [<https://perma.cc/5U9A-5XQ5>].

²⁵ *Id.*

²⁶ The CAA Amendments of 1970 directed EPA to “establish a system of uniform national emissions limits on new stationary sources” of pollution (like power plants). Hercher, *supra* note 23, at 749. In response, EPA promulgated New Source Performance Standard regulations (NSPS) for sulfur dioxide. *Id.* Many new coal-fired power plants met compliance with this regulation by “burning low-sulfur ‘compliance’ coal,” rather than installing technology (e.g., scrubbers) to treat the emissions. *Id.* This increased the demand for low-sulfur western coal, even among power plants located in the Midwest and eastern United States. *Id.* However, sulfur dioxide emissions remained problematic after the NSPS were implemented, and the “competitive edge” the NSPS gave to Western coal became a concern in Congress. *Id.* at 750. As a result, the CAA was again amended in 1977 so that newly-constructed power plants could not meet compliance only by burning low-sulfur coal. *Id.* The resulting NSPS, implemented in 1979, required new power plants “to reduce emissions from all coals by a certain [nonuniform] percentage, even if uncontrolled emissions would be below the absolute ceiling.” *Id.* The CAA was amended again in 1990 to impose a permanent nationwide emissions cap on the amount of sulfur dioxide that power plants are allowed to emit. See JUHA SIIKAMÄKI ET AL., RES. FOR THE FUTURE, THE U.S. ENVIRONMENTAL PROTECTION AGENCY’S ACID RAIN PROGRAM 1–2 (2012), <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Bck-AcidRainProgram.pdf> [<https://perma.cc/V3PT-G95W>]. A cap-and-trade program, called the Acid Rain Program, was implemented to allow plants the flexibility to decide how to meet the sulfur dioxide caps, while also creating a market-based trading system where power plants with lower sulfur dioxide emissions could sell allowances to plants with higher emissions. *Id.*

²⁷ Clean Air Act, 42 U.S.C. § 7651(b) (1994).

²⁸ David McDermott, *Coal Mining in the U.S. West: Price and Employment Trends*, 121 *MONTHLY LAB. REV.* 18, 18–19 (1997).

scrubbers.²⁹ This decision increased the demand for low-sulfur coal, most of which is found in the Western United States—especially Wyoming, Colorado, and Montana—but is also found in Central Appalachia—primarily West Virginia, eastern Kentucky, and southwest Virginia.³⁰

Since the 1990 Amendments were enacted, acid rain has decreased by more than 55%.³¹ Furthermore, between 1970 and 2007, the six criteria pollutants EPA regulates under the CAA decreased by over 50%.³² These reductions have meant improvements in not only the environment but also in public health, as these toxicants are known to cause a variety of illnesses and premature mortality.³³ However, while there have been significant benefits of the Clean Air Act to the United States as a whole, for certain people, namely those living in coal-mining communities of Central Appalachia and communities where coal-fired power plants are located, the Clean Air Act has caused unintended negative consequences for health and well-being.

²⁹ NAT'L RESEARCH COUNCIL, COAL: RESEARCH AND DEVELOPMENT TO SUPPORT NATIONAL ENERGY POLICY 98 (2007).

³⁰ ENERGY INFO. ADMIN., U.S. COAL RESERVES: AN UPDATE BY HEAT AND SULFUR CONTENT 40 (1993), <http://large.stanford.edu/publications/coal/references/docs/052992.pdf> [<https://perma.cc/5MDJ-R563>]; Hercher, *supra* note 23, at 749.

³¹ See *Progress Cleaning the Air and Improving People's Health*, EPA, <https://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health#emissions> [<https://perma.cc/3RWP-HWS6>].

³² EPA, THE PLAIN ENGLISH GUIDE TO THE CLEAN AIR ACT 2 (2007) <https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf> [<https://perma.cc/J2TF-UDVV>].

³³ Exposure to sulfur dioxide and nitrogen oxides is associated with increased rates of hospital admissions for respiratory conditions, such as asthma. RICHARD L. REVESZ & JACK LIENKE, STRUGGLING FOR AIR: POWER PLANTS AND THE "WAR ON COAL" 11 (2016). Sulfur dioxide and nitrogen oxides can also "react with other compounds in the atmosphere to form small particles . . . that can create or exacerbate serious respiratory problems, aggravate existing heart disease, and contribute to acid rain." *Id.* When coal is burned, mercury is also released and eventually settles in bodies of water, where it is converted into methylmercury, a highly toxic pollutant that bioaccumulates in fish and can cause neurological damage to developing fetuses when those fish are consumed by pregnant women. *Id.*; see also EPA OFFICE OF AIR & RADIATION, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT FROM 1990 TO 2020 (2011), https://www.epa.gov/sites/production/files/2015-07/documents/fullreport_rev_a.pdf [<https://perma.cc/DJ6B-GZUL>]; Francine Laden et al., *Association of Fine Particulate Matter from Different Sources with Daily Mortality in Six U.S. Cities*, 108 ENVTL. HEALTH PERSPS. 941, 941 (2000); Joellen Lewtas, *Air Pollution Combustion Emissions: Characterization of Causative Agents and Mechanisms Associated with Cancer, Reproductive, and Cardiovascular Effects*, 636 MUTATION RES. 95, 95 (2007); Michael Hendryx & Benjamin Holland, *Unintended Consequences of the Clean Air Act: Mortality Rates in Appalachian Coal Mining Communities*, 63 ENVTL. SCI. & POL'Y 1, 2–3 (2016).

II. ENVIRONMENTAL INJUSTICES AND THE CLEAN AIR ACT

Numerous scholars and activists have argued that the coalfields of Central Appalachia³⁴ have long served as an “energy sacrifice zone[,]”³⁵ a region where “the land and much of the population are exploited in order to keep the costs of energy low for the rest of the country.”³⁶ This region includes some of the most impoverished counties in the United States; in 2008, poverty rates in Central Appalachia were nearly 25%.³⁷ According to the Appalachian Regional Commission, “persistent socioeconomic distress and out-migration have resulted in a significant gap in human, natural, and financial capital” in Central Appalachia, “greatly hinder[ing] economic development.”³⁸

Furthermore, counties in Central Appalachia where a contentious form of coal extraction known as mountaintop removal (MTR), or mountaintop mining,³⁹ takes place experience significantly higher rates of poverty than other non-MTR and nonmining counties in the region.⁴⁰ MTR is a method of surface mining used to extract thin seams of coal buried beneath hundreds of feet of rock in the Appalachian Mountains.⁴¹ Mining companies use explosives to blast apart the mountain above the coal seam and then use large excavating machines called draglines to scrape the coal from the exposed surface.⁴² The “overburden” that is removed—consisting of rock, soil, plants, and

³⁴ Central Appalachia is one of five subregions designated by the Appalachian Regional Commission and consists of southwest West Virginia, southwest Virginia, eastern Kentucky, and eastern Tennessee. APPALACHIAN REG'L DEV. INITIATIVE, ECONOMIC ASSESSMENT OF APPALACHIA 2 (2010), <https://www.arc.gov/images/programs/ardi/EconomicAssessmentofAppalachiaJune2010.pdf> [<https://perma.cc/P89A-VREX>].

³⁵ Julia Fox, *Mountaintop Removal in West Virginia: An Environmental Sacrifice Zone*, 12 ORG. & ENV'T 163, 167 (1999); see SHANNON ELIZABETH BELL, FIGHTING KING COAL: THE CHALLENGES TO MICROMOBILIZATION IN CENTRAL APPALACHIA 16 (2016) [hereinafter BELL, FIGHTING KING COAL]; REBECCA R. SCOTT, REMOVING MOUNTAINS: EXTRACTING NATURE AND IDENTITY IN THE APPALACHIAN COALFIELDS 31 (2010).

³⁶ BELL, FIGHTING KING COAL, *supra* note 35, at 16 (footnote omitted).

³⁷ APPALACHIAN REG'L DEV. INITIATIVE, *supra* note 34, at 7.

³⁸ *Id.* at 1.

³⁹ “Mountaintop removal mining” and “mountaintop mining” are both used to describe the same method of coal extraction. See BELL, FIGHTING KING COAL, *supra* note 35, at 287 for a description of the different usage of these two terms.

⁴⁰ Michael Hendryx, *Poverty and Mortality Disparities in Central Appalachia: Mountaintop Mining and Environmental Justice*, 4 J. HEALTH DISPARITIES RES. & PRAC. 44, 48 (2011).

⁴¹ *Mountaintop Mining Research Research*, EPA (Oct. 11, 2016), <https://www.epa.gov/water-research/mountaintop-mining-research> [<https://perma.cc/2T6E-7B6R>].

⁴² BELL, FIGHTING KING COAL, *supra* note 35, at 25–26; *Mountaintop Mining Research Research*, *supra* note 41.

trees—is pushed into adjacent valleys, creating valley fills.⁴³ MTR has destroyed more than 1 million acres of land and over 500 mountains,⁴⁴ and it has also buried an estimated 2,000 miles of streams.⁴⁵ In addition to the ecological harms, coal industry practices are a major threat to public health; a growing body of public health research has demonstrated that residents living in coal-mining communities of Appalachia, especially those where MTR is practiced, suffer considerable health consequences in comparison to people living in non-coal-mining communities in the region. These studies reveal that residents in Appalachia's coal-mining communities experience higher rates of mortality,⁴⁶ cancer,⁴⁷ birth defects,⁴⁸ chronic illnesses,⁴⁹ depression,⁵⁰ and hospitalizations for respiratory and cardiovascular conditions,⁵¹ even after controlling for income, education, and other variables.

Indiana University School of Public Health researchers Michael Hendryx and Benjamin Holland argue that the 1990 Amendments to the Clean Air Act were partly responsible for the expansion of MTR mining throughout Central Appalachia beginning in the late 1990s, owing to the relatively low sulfur content of coal in this region compared to other coal-producing areas in the eastern and interior United States.⁵² To determine

⁴³ BELL, FIGHTING KING COAL, *supra* note 35, at 25–26; *Mountaintop Mining Research Research*, *supra* note 41.

⁴⁴ ROSS GEREDIEN, ASSESSING THE EXTENT OF MOUNTAINTOP REMOVAL IN APPALACHIA: AN ANALYSIS USING VECTOR DATA app. B (2009), http://ilovemountains.org/reclamation-fail/mining-extent-2009/Assessing_the_Extent_of_Mountaintop_Removal_in_Appalachia.pdf [https://perma.cc/CWL3-BMPH].

⁴⁵ David C. Holzman, *Mountaintop Removal Mining: Digging into Community Health Concerns*, 119 ENVTL. HEALTH PERSP. A476, A477 (2011).

⁴⁶ Michael Hendryx, *Mortality Rates in Appalachian Coal Mining Counties: 24 Years Behind the Nation*, 1 ENVTL. JUST. 5, 5–6 (2008).

⁴⁷ Michael Hendryx et al., *Self-Reported Cancer Rates in Two Rural Areas of West Virginia With and Without Mountaintop Coal Mining*, 37 J. COMMUNITY HEALTH 320, 320 (2012).

⁴⁸ Melissa M. Ahern et al., *The Association Between Mountaintop Mining and Birth Defects Among Live Births in Central Appalachia, 1996–2003*, 111 ENVTL. RES. 838, 838 (2011).

⁴⁹ Michael Hendryx & Melissa M. Ahern, *Relations Between Health Indicators and Residential Proximity to Coal Mining in West Virginia*, 98 AM. J. PUB. HEALTH 669, 669 (2008).

⁵⁰ Michael Hendryx & Kestrel A. Innes-Wimsatt, *Increased Risk of Depression for People Living in Coal Mining Areas of Central Appalachia*, 5 ECOPSYCHOLOGY 179, 179 (2013).

⁵¹ Michael Hendryx et al., *Hospitalization Patterns Associated with Appalachian Coal Mining*, 70 J. TOXICOLOGY & ENVTL. HEALTH PART A 2064, 2064, 2066–68 (2007).

⁵² Hendryx & Holland, *supra* note 33, at 1–2. The demand for low-sulfur western coal also increased because of the 1990 CAA Amendments. Hercher, *supra* note 23, at 749. However, western coal has a lower heat value than eastern coal, so

whether the 1990 Amendments may have had unintended health consequences in Central Appalachian coal-mining communities, Hendryx and Holland employed a panel design to examine mortality rates in Central Appalachian MTR counties and control areas, pre- and post-1990 CAA amendments. They found that in the post-CAA amendment years, counties with MTR mining experienced approximately 1200 additional deaths per year than non-MTR counties, controlling for age, smoking rate, obesity rate, poverty rate, and per-capita primary care physicians.⁵³ Hendryx and Holland suggest that a likely contributing factor to these increased deaths is the surge in air contaminants from MTR mining, including silica, other inorganics, “polycyclic aromatic hydrocarbons,” and ultrafine particles.⁵⁴ As the researchers note, exposure to MTR particulate matter has been shown to cause biological impairments in laboratory-based studies.⁵⁵ As further analyzed below, another contributing factor to the increased mortality rates in the years following the 1990 CAA Amendments may be the coal preparation process.

A. *Coal Preparation Plants, Coal Slurry, and Health Effects in Central Appalachia*

Concomitant with the proliferation of MTR mines throughout Central Appalachia in the 1990s and 2000s was an increase in the number of coal preparation plants⁵⁶ built to chemically “wash” the coal to remove noncombustible materials

more of it must be burned to achieve the same energy output as eastern coal. See *How Coal Works*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/coal_vswind/brief_coal.html#_V_s8viTxuUE [https://perma.cc/7NAW-STHA]. Also, Central Appalachian coal has a shorter distance to travel to coal-fired power plants in the eastern United States, which is another likely reason for the increased interest in Central Appalachian coal in the post-1990 CAA amendment years.

⁵³ Hendryx & Holland, *supra* note 33, at 3–4.

⁵⁴ *Id.* A 2014 study published in the journal *Environmental Science and Technology* demonstrated that dust collected from communities close to mountaintop removal mining sites causes changes to human lung cells that indicate the cancer-causing potential of this dust. See Sudjit Luanpitpong et al., *Appalachian Mountaintop Mining Particulate Matter Induces Neoplastic Transformation of Human Bronchial Epithelial Cells and Promotes Tumor Formation*, 48 ENVTL. SCI. & TECH. 12912, 12912–13 (2014).

⁵⁵ Travis L. Knuckles et al., *Air Pollution Particulate Matter Collected from an Appalachian Mountaintop Mining Site Induces Microvascular Dysfunction*, 20 MICROCIRCULATION 158, 158–59 (2013); Luanpitpong et al., *supra* note 54, at 12912; Cody E. Nichols et al., *Cardiac and Mitochondrial Dysfunction Following Acute Pulmonary Exposure to Mountaintop Removal Mining Particulate Matter*, 309 AM. J. PHYSIOLOGY HEART & CIRCULATORY PHYSIOLOGY H2017, H2017 (2015).

⁵⁶ See Steve Fiscor, *2015 U.S. Prep Plant Census*, COAL AGE, Oct. 2015, at 28–29, 31–33, <http://coal.epubxp.com/i/589434-oct-2015/27> [https://perma.cc/8LJC-LWFP].

(such as shale, clay, or slate) and pollutants like sulfur.⁵⁷ Whereas western coal deposits are typically found in thick seams of low-sulfur coal,⁵⁸ most of the coal in the eastern United States occurs as “thin bands of coal-bearing sediments mixed with sedimentary rock”⁵⁹ that is higher in sulfur content than western coal.⁶⁰ Because of this composition, coal preparation facilities are necessary to remove the waste rock from the coal,⁶¹ a process that also reduces the sulfur content.⁶² Processing reduces shipping costs, improves the heating properties of the coal, and minimizes its environmental impacts.⁶³

The 2015 U.S. Prep Plant Census, conducted annually by *Coal Age* magazine, reports a total of 269 coal preparation plants in the United States.⁶⁴ As shown in Table 1, of the 184 plants that either responded to the 2015 or a previous year’s census, 100 (54%) were built in the years following the 1990 CCA Amendments, 54 (29%) were built in the years following the 1977 CAA Amendments, and 30 (16%) were built before 1977. Furthermore, the majority of the coal preparation plants are in Appalachian and midwestern states, most notably West Virginia and Kentucky.⁶⁵ As Table 1 reveals, only 9 of the 269 coal preparation plants are in western states (Colorado, Montana, and Utah) due to the composition of this coal, which, as described above, is mostly composed of thick seams of low-sulfur coal that typically does not need much processing beyond crushing and screening to sort coal particles by size.⁶⁶

⁵⁷ HAROLD J. GLUSKOTER ET AL., VA. CTR. FOR COAL & ENERGY RESEARCH, MEETING PROJECTED COAL PRODUCTION DEMANDS IN THE USA: UPSTREAM ISSUES, CHALLENGES, AND STRATEGIES 107–08 (2009), https://www.energy.vt.edu/NCEPStudy/outline/Coal_Production_Demands.pdf [<https://perma.cc/45ER-TFPU>].

⁵⁸ *Id.* at 118.

⁵⁹ *Id.* at 119.

⁶⁰ *Id.*

⁶¹ *Id.*

⁶² *Id.* Sulfur content reduction is a secondary benefit of processing as the primary aim of processing is to reduce the ash content. *Id.*

⁶³ *Id.* at 107.

⁶⁴ Fiscor, *supra* note 56, at 26.

⁶⁵ *See id.*

⁶⁶ GLUSKOTER ET AL., *supra* note 57, at 118.

TABLE 1. Total U.S. Coal Preparation Plants by State, Prep Plants Reporting Year They Were Built, and Years They Were Built⁶⁷

State	Total Plants	Plants Reporting Year Built	Built Before 1977	Built 1977–1989	Built 1990 and Later
Alabama	8	7	3	1	3
Colorado	5	4	0	1	3
Illinois	15	14	2	4	8
Indiana	16	15	1	2	12
Kentucky	57	34	4	14	16
Maryland	2	2	0	1	1
Montana	1	1	0	0	1
Ohio	19	11	2	3	6
Pennsylvania	43	21	7	5	9
Tennessee	3	1	0	1	0
Utah	3	1	0	0	1
Virginia	18	10	0	8	2
West Virginia	79	63	11	14	38
TOTAL	269	184	30 (16%)	54 (29%)	100 (54%)

West Virginia is the second foremost producer of coal in the nation, and Kentucky is the third.⁶⁸ As shown in Table 1, together,

⁶⁷ Source of data: Fiscor, *supra* note 56.

⁶⁸ *West Virginia*, ENERGY INFO. ADMIN., <http://www.eia.gov/state/rankings/?sid=WV#series/48> [https://perma.cc/45NM-9RWU].

these two Central Appalachian states are home to more than half of the nation's 269 coal preparation plants.⁶⁹ As noted above, coal-mining communities in West Virginia and Kentucky suffer numerous environmental and economic injustices and have a history of exploitation by extractive industries,⁷⁰ leaving behind a legacy of contamination and pollution.⁷¹ The construction of coal preparation plants and the technology these plants employ to wash the coal have exacerbated the environmental health problems coal communities face.⁷²

Washing coal generates a large quantity of liquid coal waste, known as slurry or "sludge."⁷³ This coal slurry not only consists of the chemicals used to wash the coal, but it also includes water and small particles of coal, "which contain a host of heavy metals and semi-metal compounds that can be toxic when ingested or inhaled."⁷⁴ Some of these compounds include "arsenic, beryllium, cadmium, chromium, cobalt, lead, mercury, nickel, and selenium."⁷⁵ Communities whose water has been contaminated with coal slurry have been found to have high rates of respiratory diseases, renal/pelvic diseases, cancers, and even organ failure.⁷⁶

Coal slurry is either stored in vast open-air impoundments on top of mountaintop removal mine sites—with a capacity to hold millions or billions of gallons of coal waste—or injected into abandoned underground mine shafts.⁷⁷ Both methods of storage have the potential to cause serious problems in nearby communities. Above-ground impoundments

⁶⁹ Fiscor, *supra* note 56.

⁷⁰ The term *extractive industries* "[u]sually refers to the oil, gas and mining industries." *The EITI Glossary*, EITI, <https://eiti.org/glossary> [<https://perma.cc/CP62-4WX3>].

⁷¹ BELL, FIGHTING KING COAL, *supra* note 35, at 16–18, 24–35; Shannon Elizabeth Bell & Richard York, *Community Economic Identity: The Coal Industry and Ideology Construction in West Virginia*, 75 RURAL SOC. 111, 123–26 (2010); Shannon Elizabeth Bell & Yvonne A. Braun, *Coal, Identity, and the Gendering of Environmental Justice Activism in Central Appalachia*, 24 GENDER & SOC'Y 794, 800 (2010).

⁷² Paul R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 ANNALS N.Y. ACAD. SCI. 73, 80–81 (2011); SHANNON ELIZABETH BELL, OUR ROOTS RUN DEEP AS IRONWEED: APPALACHIAN WOMEN AND THE FIGHT FOR ENVIRONMENTAL JUSTICE 28–43, 61–83 (2013).

⁷³ BELL, FIGHTING KING COAL, *supra* note 35, at 1; GLUSKOTER ET AL., *supra* note 57, at 117–18.

⁷⁴ BELL, FIGHTING KING COAL, *supra* note 35, at 1.

⁷⁵ *Id.*

⁷⁶ Dr. William H. Orem, Address at the W. Va. Joint Judiciary Subcomm. Hearing 4–5 (Nov. 15, 2006), http://ohvec.org/galleries/people_in_action/2006/11_15/transcription.pdf [<https://perma.cc/E6E5-EHTZ>] Leigh Ann Wells, *Lawsuits Muddy Water Project*, APPALACHIAN NEWS-EXPRESS (July 30, 2006), http://ohvec.org/news/letters/woc_2006_09/article_03.html [<https://perma.cc/2U6R-D4A7>]; BELL, *supra* note 72, at 45, 61, 63, 65, 72.

⁷⁷ BELL, FIGHTING KING COAL, *supra* note 35, at 28–29.

create disaster risks for communities below these sites. For instance, in 1972 a massive coal slurry impoundment collapse in West Virginia sent a flood of black coal waste through Buffalo Creek Hollow, killing 125 people and leaving thousands homeless.⁷⁸ Another example is the Martin County, Kentucky disaster of 2000 that spilled 250 million gallons of coal waste and polluted more than 70 miles of Kentucky and West Virginia waterways, killing wildlife and contaminating homes and water supplies.⁷⁹ As of 2006, there were 126 slurry impoundments—permitted to hold over 110 billion gallons of slurry—in West Virginia alone.⁸⁰ A 2011 study conducted for the Office of Surface Mining Reclamation and Enforcement revealed that many of these slurry impoundments have dangerously weak walls.⁸¹ Of the 73 field density tests performed at 7 impoundment sites in West Virginia, only 16 (22%) passed.⁸²

B. *Drinking-Water Contamination*

As noted above, only a portion of the coal waste that is generated from preparation plants is stored in slurry impoundments; some coal operations pump their coal waste into abandoned (and unlined) mine shafts, leaving nearby communities, many of which draw their water from wells, at risk for contamination of their drinking-water supplies.⁸³ Many people living with contaminated water from such coal slurry injection sites did not realize at first that their discolored tap water was coal waste; they either thought—or were explicitly told by the health department—that it was just iron in their water or soil getting through their filters.⁸⁴ Many continued to use the water for drinking, cooking, and bathing until enough people in the community—especially children—began getting

⁷⁸ KAI T. ERIKSON, *EVERYTHING IN ITS PATH: DESTRUCTION OF COMMUNITY IN THE BUFFALO CREEK FLOOD* 1, 40 (1976).

⁷⁹ Fred Stroud & Robert Kelly, EPA, to Doug Lair, EPA Region IV & Charlie Kleeman, EPA Region III, *Kentucky/West Virginia Coal Slurry Spill Martin County Coal Corporation Inez, Kentucky 1–2* (Oct. 31, 2000), <https://www.epa.gov/sites/production/files/2014-03/documents/polrep7.pdf> [<https://perma.cc/2FZL-VHFH>].

⁸⁰ Epstein et al., *supra* note 72, at 81.

⁸¹ Juliet Eilperin & Steven Mufson, *Many Coal Sludge Impoundments Have Weak Walls, Federal Study Says*, WASH. POST (Apr. 24, 2013), https://www.washingtonpost.com/national/health-science/many-coal-sludge-impoundments-have-weak-walls-federal-study-says/2013/04/24/76c5be2a-acf9-11e2-a8b9-2a63d75b5459_story.html [<https://perma.cc/Q3D3-JEEX>].

⁸² *Id.*

⁸³ BELL, *FIGHTING KING COAL*, *supra* note 35, at 29–30.

⁸⁴ *Id.* at 2, 30.

sick, prompting residents to suspect the water might be the cause.⁸⁵ Over the past decade, increased attention has been brought to coal-waste contamination throughout the Central Appalachian region.⁸⁶ One example is the community of Prenter in Boone County, West Virginia.

In 2008, Maria Lambert and other Prenter residents started worrying that their well water was contaminated with coal slurry from a nearby underground slurry injection site. In my interview with her in 2008, Maria described the community meeting she and her parents attended where they first discovered that the water could be dangerous to consume. At that meeting,

[e]verybody was showing [samples of] their water. Different people stood up and told about their water and told about what they believed was happening, and told about the different illnesses—the brain tumors, the gallbladder problems, stomach problems, children’s teeth falling out, and all of these things. . . . And it’s like, a light bulb going off all here, there, yonder, everywhere. And it’s like my whole life flashing before my eyes, because my children had lost their teeth, my parents had had cancer, we’d had our gallbladders removed, and all of these things was, it’s just like, oh no, it’s not just us—it’s the whole community⁸⁷

The following week, Maria went to the hospital with intestinal bleeding, which she asserted was from drinking the water all summer long in an effort to lose weight. As she described,

I never really got that mad about anything [before this], I don’t think. I think that was the straw that broke the camel’s back. It just infuriated me to think that my husband had spent twenty-three-and-a-half years in the ground [coal mining], my dad had worked for the mining industry for twenty-five years, my grandfather worked for about twenty-something, thirty-something years in the mines. His father was killed in the mines. And to know that they gave their all, *everything* they had, they put into that work.⁸⁸

Donetta Blankenship from Rawl, West Virginia is another victim of water contamination from a breach in an underground

⁸⁵ *Id.* at 2, 29–30; see BELL, *supra* note 72, at 61–65, 72–74.

⁸⁶ Michael Hendryx et al., *Public Drinking Water Violations in Mountaintop Coal Mining Areas of West Virginia, USA*, 4 WATER QUALITY EXPOSURE & HEALTH 169, 169–70 (2012); Wilson Dizard, *Coal Mining’s Long Legacy of Water Pollution in West Virginia*, AL JAZEERA AM. (Jan. 13, 2014), <http://america.aljazeera.com/articles/2014/1/13/coal-pollution-miningwestvirginiamassey.html> [<https://perma.cc/3WSG-ZUXS>].

⁸⁷ BELL, *supra* note 72, at 72 (alteration and first omission in original).

⁸⁸ *Id.* at 78–79 (alteration in original).

coal-waste injection site. In our 2007 interview, she recounted the story of her coal-waste-induced illness, stating,

I started getting sick at the end of February 2005. . . . I stayed nauseous, I stayed tired. My urine was changing colors. I started having problems with my eyes. . . .

The first week of April, I started noticing I could look at my skin, and it looked a little yellow. . . . I thought maybe it was the sun doing it to me. And, my husband, he kinda noticed it, even getting in my eyes. You know, the white parts of my eyes was lookin' yellow. . . .

. . . .

I ended up having to go to the hospital. . . . My enzymes—liver enzymes—was up in the—it was close to 10,000.⁸⁹

A “high” level of alanine aminotransferase (ALT), the liver enzyme Donetta is describing above, is greater than fifty units per liter of blood.⁹⁰ According to David E. Johnston, MD, from the University of New Mexico School of Medicine, ALT levels above 10,000 units per liter are “usually found in patients with acute toxic injury.”⁹¹ Doctors conducted test after test to determine the cause of Donetta’s life-threatening illness. Finally, one test revealed high levels of heavy metals, particularly copper, in her bloodstream, and it was determined that Donetta’s well water had caused her to come close to liver failure at age thirty-eight.⁹²

C. *Coal Dust*

Water contamination from coal slurry is not the only way that communities suffer from coal preparation facilities; pollution from coal dust can be another effect.⁹³

One example is the Central Appalachian coalfield town of Sylvester in Boone County, West Virginia. This community was showered with coal dust on a daily basis starting in 1998 when a coal company expanded its coal processing facility to a piece of land adjacent to the town.⁹⁴ The coal company built a

⁸⁹ *Id.* at 62.

⁹⁰ George Aragon & Zobair M. Younossi, *When and How to Evaluate Mildly Elevated Liver Enzymes in Apparently Healthy Patients*, 77 CLEV. CLINIC J. MED. 195, 196 (2010).

⁹¹ David E. Johnston, *Special Considerations in Interpreting Liver Function Tests*, 59 AM. FAM. PHYSICIAN 2223 (1999). In other words, an injury caused to the liver by a toxin of some kind. *Id.*

⁹² BELL, *supra* note 72, at 61, 65.

⁹³ *See id.* at 28–29; BELL, FIGHTING KING COAL, *supra* note 35, at 31–33.

⁹⁴ BELL, *supra* note 72, at 28–29.

coal-crushing unit⁹⁵ at a facility called a stoker plant, which “produces screened, small dimension coal” for power plants.⁹⁶ Initially, there were no protections in place to shield the community from the very fine dust, which made life unbearable for many residents.⁹⁷ As the late Pauline Canterbury, a longtime resident of Sylvester, described in our 2007 interview:

Just as soon as they got [the preparation plant] finished and it started into operation, which was in April of 1998, it *instantly* began to cover the town in coal dust. Within one month we were completely covered. It was horrible. We could walk outside here on [sunny] days like today and the sun looked like you was looking through a kaleidoscope, there was so much coal dust in the air. You couldn’t do nothing outside—you couldn’t have cookouts outside, you [couldn’t] hang your clothes outside when you wash[ed] them. It just *plastered* our homes. And not only that, then it began to seep through your windows and inside your home. . . . it’s everywhere. Your attics are full of it, everything is full of it.⁹⁸

The coal dust destroyed residents’ homes and robbed them of a substantial amount of their resale value. As Pauline told me, “You know, it’s not easy to sit and watch your home being destroyed, something you have worked for all your life. . . . We found out through our lawsuit—because we all had our homes appraised [for it]—that our homes have lost 90 percent of their value.”⁹⁹ In the 1990s, the home of Mary Miller, another Sylvester resident, appraised for \$144,000.¹⁰⁰ After the preparation plant had begun to spew coal dust on the town, it appraised for only \$12,000.¹⁰¹ As Mary told me in our interview:

I just think that’s about the worst thing [that] could happen to somebody—when you see that you’ve worked all your life for this, and you’re losing what you’ve loved and worked for. There’s no inheritance. There’s nothing, not even enough to bury us. Twelve thousand dollars wouldn’t even built a garage, and like I said, it’s certainly not going to bury us. If [we’d] ever have to go and borrow

⁹⁵ Kari Lydersen, *West Virginia Town Fights Blanket of Coal Dust*, NEW STANDARD (May 9, 2006), <http://newstandardnews.net/content/index.cfm/items/3140> [<https://perma.cc/P96S-CFT9>]; see BELL, *supra* note 72, at 29.

⁹⁶ Massey Energy Co., Annual Report (Form 10-K) (Mar. 1, 2011), <https://www.sec.gov/Archives/edgar/data/37748/000114036111013070/form10k.htm#a004> [<https://perma.cc/2HRJ-W8CF>].

⁹⁷ BELL, *supra* note 72, at 28–38; see Lydersen, *supra* note 95.

⁹⁸ BELL, *supra* note 72, at 28–29 (second, third, and fourth alterations in original).

⁹⁹ *Id.* at 35–36.

¹⁰⁰ *Id.* at 36.

¹⁰¹ *Id.*

money, what have [we] got to put up for collateral? There's nothing there. Nothing.¹⁰²

Reflecting on this experience, Pauline asserted,

[W]e've been discriminated against. We're being sacrificed here for energy for the rest of the world, for more money for people that already has more than they know what to do with, and it isn't right. To me, it's not the American Way, it will never be the way of the America that I envision we're supposed to be here. . . . [I]t's just for greed. Why should we give up everything we own for somebody else to have cheap energy? For a world of people that's already pampered to death. It's the injustice of it.¹⁰³

Sylvester residents' experiences demonstrate how living next to a coal preparation facility can negatively affect community members' health and quality of life in significant ways. Just 12 miles from Sylvester, close to Sundial, West Virginia, is another example. This site is home to a mountaintop removal mine, a 2.8 billion gallon coal slurry impoundment, and a coal preparation facility with a coal storage silo.¹⁰⁴ Up until 2013, an elementary school with 230 children operated just a few hundred yards from the preparation plant, 225 yards from the coal silo, and directly below the coal slurry impoundment.¹⁰⁵ Concerns about the safety and health of the children—whose lives would have been threatened if the slurry impoundment failed,¹⁰⁶ and who were attending a school that had been found to have unsafe levels of coal dust present in the classrooms¹⁰⁷—motivated a multi-year fight to have a new elementary school built in a safer location.¹⁰⁸ The elevated levels of coal dust at the school prompted members of an environmental justice organization to conduct a door-to-door health survey of homes within the vicinity of the school.¹⁰⁹ Of the 60 homes they surveyed with children, 55 reported at least 1 child with a respiratory problem (such as asthma).¹¹⁰

¹⁰² *Id.* (alterations in original).

¹⁰³ *Id.* at 38–39.

¹⁰⁴ *Id.* at 113–14.

¹⁰⁵ *Id.* at 113, 119.

¹⁰⁶ *Id.* at 115.

¹⁰⁷ *Id.* at 116–17.

¹⁰⁸ Thanks to the hard work of environmental justice activists, enough money was raised to build a new Marsh Fork Elementary School a few miles from the original school. The new school opened on January 7, 2013. *Id.* at 118–19.

¹⁰⁹ *Id.* at 116–17.

¹¹⁰ *Id.* at 117.

The proliferation of coal preparation plants in Central Appalachia—a consequence of the increased demand for low-sulfur Central Appalachian coal resulting from the Clean Air Act-mandated reductions in sulfur dioxide emissions¹¹¹—has brought additional environmental health threats, in the form of coal dust and toxic coal slurry, to a region already suffering a disproportionate burden of environmental injustices.¹¹² Jack Spadaro, a former top safety trainer for the Mine Safety and Health Administration, maintained that the most prevalent methods of cleaning coal—which require slurry impoundments and slurry injections for the disposal of huge volumes of liquid waste—have been used to “save[] a dollar a ton in processing.”¹¹³ Other technologies for washing coal, such as dry filter press systems, have existed since the 1960s.¹¹⁴ “Coal impoundments are not at all necessary,” Spadaro asserted. “It would only cost about a dollar a ton more. . . . Overall the industry simply doesn’t give a damn about the people or the environment in this region [of the country]. And I can say that with authority.”¹¹⁵ As is reflected in Spadaro’s sentiment, most industries cannot be trusted to choose the most environmentally sound methods of production in the absence of regulations because those methods are typically more expensive.¹¹⁶ As environmental justice scholar and Professor of Sociology Daniel Faber argued in *Capitalizing on Environmental Injustice: The Polluter-Industrial Complex in the Age of Globalization*, “Without prohibitions and the threat of punitive actions by state regulatory agencies or the courts, it is simply more profitable for corporations to pollute.”¹¹⁷

D. Coal-Fired Power Plants: Trading One Form of Pollution for Another

After coal is washed and processed, it is transported via truck, train, or barge to coal-fired power plants throughout the United States. An outcome of the Clean Air Act Amendments of

¹¹¹ Hendryx & Holland, *supra* note 33, at 1.

¹¹² BELL, *FIGHTING KING COAL*, *supra* note 35, at 16–18, 24–33; BELL, *supra* note 72, at 1–2, 177.

¹¹³ Jack Spadaro, APPALACHIAN VOICES (Apr. 1, 2006), <http://appvoices.org/2006/04/01/2831/> [<https://perma.cc/2USZ-8YFY>] (original interview conducted by Vivian Stockman).

¹¹⁴ *Id.*

¹¹⁵ *Id.*

¹¹⁶ DANIEL FABER, *CAPITALIZING ON ENVIRONMENTAL INJUSTICE: THE POLLUTER-INDUSTRIAL COMPLEX IN THE AGE OF GLOBALIZATION* 24 (2008).

¹¹⁷ *Id.*

1977 was that newly built¹¹⁸ coal-fired power plants were incentivized to install scrubbers to reduce the amount of sulfur dioxide and other pollutants released into the air when coal is burned.¹¹⁹ As noted above, the pollution emitted from the smokestacks of these power plants (in the form of soot) has declined significantly in recent decades.¹²⁰ But while the volume of toxicants emitted from smokestacks may be smaller, the coal combustion waste, or coal ash, left behind in power plants after coal is burned is far more toxic than the coal ash produced in plants without scrubbers.¹²¹ Coal combustion waste from coal plants can contain a variety of metals that are harmful to humans, including arsenic, selenium, lead, mercury, beryllium, vanadium, cadmium, cobalt, and chromium among others.¹²² Exposure to these metals over time can cause cancer, lung disease, kidney disease, and problems with the heart, nervous system, gastrointestinal tract, and reproductive system. Children and infants are particularly vulnerable to the metals contained in coal combustion waste, as these toxicants can cause birth defects and bone growth impairments, as well as cognitive, developmental, and behavioral problems.¹²³ Thus, through enacting the regulations in the Clean Air Act, air pollution has been traded for another form of toxic waste.¹²⁴

In 2008, an estimated 136 million tons of coal combustion waste were generated in the United States, “making it one of the largest waste streams” in the country.¹²⁵ Of these 136 million tons of coal combustion waste, 86 million tons (63%) went into landfills, surface impoundments, or mines.¹²⁶ Another 50 million tons were converted into usable materials, including building materials (like cement) “or as a substitute for sand or gravel.”¹²⁷

¹¹⁸ Older coal-fired plants built prior to the 1970 Clean Air Act were “grandfathered” in and did not have to operate under the same emissions standards. See REVESZ & LIENKE, *supra* note 33, at 3–4.

¹¹⁹ McDermott, *supra* note 28, at 18–19.

¹²⁰ See *Progress Cleaning the Air and Improving People’s Health*, *supra* note 31.

¹²¹ BARBARA GOTTLIEB ET AL., PHYSICIANS FOR SOCIAL RESPONSIBILITY & EARTHJUSTICE, COAL ASH: THE TOXIC THREAT TO OUR HEALTH AND ENVIRONMENT, at viii (2010); D. KOSSON ET AL., EPA, CHARACTERIZATION OF COAL COMBUSTION RESIDUES FROM ELECTRIC UTILITIES—LEACHING AND CHARACTERIZATION DATA, at ii (2009).

¹²² GOTTLIEB ET AL., *supra* note 121, at vii.

¹²³ *Id.*

¹²⁴ See *id.* at viii.

¹²⁵ LINDA LUTHER, CONG. RESEARCH SERV., R41341, REGULATING COAL COMBUSTION WASTE DISPOSAL: ISSUES FOR CONGRESS 1 (2010), <http://www.fas.org/sgp/crs/misc/R41341.pdf> [<https://perma.cc/9RES-DG85>].

¹²⁶ *Id.* at 8.

¹²⁷ *Id.*

In 2009, EPA identified 629 coal combustion waste surface impoundment ponds in 42 states and estimated that there were an additional 300 coal combustion waste landfills.¹²⁸ According to a risk assessment conducted by EPA, coal combustion waste deposited in unlined landfills and surface impoundments poses a high risk of exposure to a variety of carcinogens and other toxic substances, such as arsenic, selenium, and lead.¹²⁹ Despite identifying the health risks associated with coal combustion waste disposal in unlined landfills and surface impoundments, EPA found through a survey of states that 67% did “not have liner requirements for surface impoundments,” 61% did “not have minimum groundwater monitoring for surface impoundments,” 36% did “not have minimum liner requirements for landfills,” and 19% did “not have minimum groundwater monitoring for landfills.”¹³⁰

This lack of regulatory oversight prompted EPA to propose federal oversight of coal combustion waste disposal, which went into effect in October of 2015.¹³¹ However, much damage had already been done. Several catastrophic, accidental coal combustion waste releases had polluted hundreds of miles of waterways in the United States, including the Tennessee Valley Authority spill of 2008, which released 5.4 million cubic yards (1.1 billion gallons) of coal ash slurry into a branch of the Emory River,¹³² and the Duke Energy spill of 2014, which contaminated 70 miles of the Dan River in North Carolina with “39,000 tons of coal ash” and an additional “27 million gallons of ash slurry.”¹³³ While these events were high-profile disasters, a 2010 Congressional Research Report on coal combustion waste noted that smaller releases and leachings of heavy metals occur regularly from the many unlined coal combustion waste surface impoundments and landfills in the United States.¹³⁴

Coal-fired power plants typically dispose of a portion of their coal combustion waste in wet ash ponds or dry landfills on

¹²⁸ *Id.*

¹²⁹ *Id.* at 11.

¹³⁰ *Id.* at 9.

¹³¹ Disposal of Coal Combustion Residuals from Electric Utilities, 40 C.F.R. pts. 257, 261 (2015).

¹³² See *EPA Response to Kingston TVA Coal Ash Spill*, EPA, <https://www.epa.gov/tn/epa-response-kingston-tva-coal-ash-spill> [<https://perma.cc/NVT2-CBTN>].

¹³³ David Zucchini, *Duke Energy Fined \$102 Million for Polluting Rivers with Coal Ash*, L.A. TIMES (May 14, 2015), <http://www.latimes.com/nation/la-na-duke-energy-coal-ash-20150514-story.html> [<https://perma.cc/UHJ8-3TXE>].

¹³⁴ LUTHER, *supra* note 125, at 1.

site;¹³⁵ thus, nearby communities must bear the environmental health costs of the air pollution generated by these power plants *and* their coal combustion waste sites. Like other polluting facilities, coal-fired power plants are overwhelmingly located in low-income or people-of-color communities.¹³⁶ Thus, here again, socially vulnerable populations have been forced to shoulder the unintended consequences of the Clean Air Act.

III. PREVENTING UNINTENDED CONSEQUENCES FROM EFFORTS TO MOVE TO A POST-CARBON WORLD

Although the purpose of the CAA was to create a healthier environment in the United States, it has resulted in a number of severe unintended environmental health consequences for certain vulnerable populations. Unfortunately, many of the proposed efforts for moving toward a post-carbon world may be plagued by a similar fate. As it is becoming clear to the international community, action must be taken quickly to curb greenhouse gas emissions by moving away from burning fossil fuels. Replacing fossil fuels with renewable energy sources, such as solar, wind, geothermal, bioenergy, and hydroelectric, is perhaps the most commonly discussed “solution” to climate change.¹³⁷ However, there are two main problems with this approach: (1) simply replacing fossil fuels with renewables without broad measures to reduce overall energy consumption will not be enough to stop the use of fossil fuels and (2) there are numerous unintended environmental-justice consequences linked to the expansion of renewable energy—especially solar—that have not been adequately addressed.

Richard York, Professor of Sociology and Environmental Studies at the University of Oregon, reveals in his 2012 cross-national study of energy-use patterns over the past fifty years¹³⁸ that the implementation of renewable energy production has not replaced fossil fuels on a one-to-one unit basis, but has rather

¹³⁵ See GOTTLIEB ET AL., *supra* note 121, at vi.

¹³⁶ NAACP, COAL BLOODED: PUTTING PROFITS BEFORE PEOPLE 15 (2012), <http://action.naACP.org/page/-/Coal%20Blooded%20Report%2011.15.2012.pdf> [<https://perma.cc/Z8YM-2QC7>].

¹³⁷ *Solutions to Climate Change*, GREENPEACE INT'L., <http://www.greenpeace.org/international/en/campaigns/climate-change/Solutions/> [<https://perma.cc/VSK3-K9XB>]; *Successful Strategies: Renewable Electricity Standards (2009)*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/renewable-energy.html#.WAg4tyTxu3A [<https://perma.cc/D2YZ-L8TF>].

¹³⁸ Richard York, *Do Alternative Energy Sources Displace Fossil Fuels?*, 2 NATURE CLIMATE CHANGE 441, 441 (2012).

increased the overall amount of energy consumed.¹³⁹ Cross-nationally, the general pattern York found was that for each unit of total energy use generated by non-fossil-fuel sources, “less than one quarter of a unit of fossil-fuel energy was displaced.”¹⁴⁰ And in the case of electricity, this pattern was even more pronounced: one unit of electricity generated by a non-fossil-fuel source displaced “less than one tenth of a unit of fossil-fuel-generated electricity.”¹⁴¹ In his book *Green Illusions: The Dirty Secrets of Green Energy and the Future of Environmentalism*, Ozzie Zehner articulated the same phenomenon, calling it the “Energy Boomerang Effect.”¹⁴² As he described it, the production of alternative energy places a downward pressure on prices, which stimulates demand and “entrenches energy-intensive modes of living,” thereby requiring more energy than the amount needed before the shift in production started.¹⁴³ In other words, “we create an energy boomerang—the harder we throw, the harder it will come back to hit us on the head.”¹⁴⁴

Energy efficiency is not a magic bullet, either. The “Jevons Paradox”¹⁴⁵ describes the phenomenon whereby increasing efficiency has the effect of increasing the consumption of that resource because it has become less expensive to use.¹⁴⁶ Thus, while energy efficiency can be an important aspect of decreasing energy use, in some cases it can actually have the opposite effect and increase energy consumption. York’s and Zehner’s studies reveal that without policies aimed at reducing overall energy consumption—such as Robert King’s¹⁴⁷ suggestion that we institute a cap on energy production—displacing fossil fuels with renewable energy will be a daunting task.¹⁴⁸

Moreover, there are many unintended consequences of renewable energy sources; this is particularly true with solar, which has been expanding at a staggering rate. In 2015, “solar

¹³⁹ *Id.*

¹⁴⁰ *Id.*

¹⁴¹ *Id.*

¹⁴² OZZIE ZEHNER, *GREEN ILLUSIONS: THE DIRTY SECRETS OF CLEAN ENERGY AND THE FUTURE OF ENVIRONMENTALISM* 172 (2012).

¹⁴³ *Id.*

¹⁴⁴ *Id.*

¹⁴⁵ JOHN BELLAMY FOSTER ET AL., *THE ECOLOGICAL RIFT: CAPITALISM’S WAR ON THE EARTH* 170–81 (2010).

¹⁴⁶ *Id.*

¹⁴⁷ Robert E. King, *Cap the Grid*, in *ENERGY: OVERDEVELOPMENT AND THE DELUSION OF ENDLESS GROWTH* 235–37 (Tom Butler & George Wuerthner eds., 2012).

¹⁴⁸ York, *supra* note 138, at 441; see ZEHNER, *supra* note 142, at 172.

accounted for 29.4% of new electric generating capacity installed in the U.S.,”¹⁴⁹ and in the first quarter of 2016, it accounted for 64%.¹⁵⁰ Solar energy was first developed forty years ago, and in May of 2016, the millionth solar panel was installed in the United States.¹⁵¹ It is estimated that in just two more years, another one million panels will be installed.¹⁵² Twenty-nine states plus the District of Columbia have enacted some type of renewable portfolio standard—also called a renewable energy standard, or RES—which mandates “utility companies to source a certain amount of the energy they generate or sell from renewable sources such as wind and solar.”¹⁵³ While the RPSs vary state-to-state, as of 2013, sixteen states plus the District of Columbia had provisions (called “carve-outs”) specifically for solar or distributed electricity generation that favors solar.¹⁵⁴ These RPSs have been a major driver of growth in renewable electricity generation, especially in solar, in the United States in recent years.¹⁵⁵ While the expansion of solar power has been lauded as critical for the goal of curbing carbon emissions, there are a number of very serious environmental justice concerns related to the production and disposal of solar panels that have not been fully addressed.

A number of hazardous materials are used and created in the manufacturing of solar photovoltaic (PV) panels, such as

¹⁴⁹ Cory Honeyman et al., *Solar Market Insight Report 2015 Q4*, SOLAR ENERGY INDUS. ASS’N, <https://www.seia.org/research-resources/solar-market-insight-2015-q4> [https://perma.cc/R4GK-WJX2].

¹⁵⁰ Cory Honeyman et al., *Solar Market Insight Report 2016 Q2*, SOLAR ENERGY INDUS. ASS’N, <http://www.seia.org/research-resources/solar-market-insight-report-2016-q2> [https://perma.cc/LM6S-J2J6].

¹⁵¹ Jessica Stone, *Experts at Industry Summit Say Solar Power Expanding Faster than Ever*, CCTV AM. (May 11, 2016), <http://www.cctv-america.com/2016/05/11/experts-at-industry-summit-say-solar-power-expanding-faster-than-ever> [https://perma.cc/R4YL-Y86S].

¹⁵² *Id.*

¹⁵³ *Renewable Energy Standards*, SOLAR ENERGY INDUS. ASS’N, <http://www.seia.org/policy/renewable-energy-deployment/renewable-energy-standards> [https://perma.cc/484P-H58G].

¹⁵⁴ WARREN LEON, CLEAN ENERGY STATES ALL., *THE STATE OF STATE RENEWABLE PORTFOLIO STANDARDS 10* (2013), <http://cesa.org/assets/2013-Files/RPS/State-of-State-RPSs-Report-Final-June-2013.pdf> [https://perma.cc/8WEE-JSRC]. *Distributed electricity generation* is electricity “generated at or near the point of use.” BRANDON OWENS, *THE RISE OF DISTRIBUTED POWER 10* (2014), <https://www.ge.com/sites/default/files/2014%2002%20Rise%20of%20Distributed%20Power.pdf> [https://perma.cc/V2ME-L6HM].

¹⁵⁵ GALEN BARBOSE, LAWRENCE BERKELEY NAT’L LAB., *U.S. RENEWABLES PORTFOLIO STANDARDS: 2016 ANNUAL STATUS REPORT 13–14* (2016), <https://emp.lbl.gov/sites/all/files/lbnl-1005057.pdf> [https://perma.cc/Y2BP-P4AC].

lead, cadmium, chromium, and brominated flame retardants.¹⁵⁶ Many of the chemical components of solar panels are manufactured in Global South nations¹⁵⁷ where environmental and worker safety regulations are lax,¹⁵⁸ leading to devastating consequences for local populations. For instance, in China, the growth in factories making polysilicon—used in solar PV panel manufacturing—has led to widespread pollution of the land and water.¹⁵⁹ The high costs of recycling the toxic byproduct of polysilicon production, silicon tetrachloride, has prompted some companies to simply dump the chemical directly onto fields, poisoning the land with acids and polluting the air with hydrogen chloride gas (which is formed when silicon tetrachloride is exposed to humid air).¹⁶⁰

Most solar PV panels only have a usable lifespan of about thirty years,¹⁶¹ after which they must be disposed of. Solar panels “contain many of the same [toxic] materials as electronic waste (e-waste)” in addition to a number of new materials that are challenging to recycle.¹⁶² Solar panels that end up in landfills can leach toxic metals into groundwater supplies, and those that are incinerated can release toxic materials into the air.¹⁶³ Global South nations around the world have become the dumping grounds for e-waste generated by richer countries.¹⁶⁴ Despite international treaties like the Basel Convention¹⁶⁵ that ban Global North countries from exporting their e-waste to Global

¹⁵⁶ See DUSTIN MULVANEY ET AL., TOWARD A JUST AND SUSTAINABLE SOLAR ENERGY INDUSTRY 19 (2009), <http://solarscorecard.com/2009/2009-Solar-Whitepaper.pdf> [<https://perma.cc/HDV9-6M5G>].

¹⁵⁷ *Id.* at 3.

¹⁵⁸ FABER, *supra* note 116, at 187.

¹⁵⁹ Ariana Eunjung Cha, *Solar Energy Firms Leave Waste Behind in China*, WASH. POST (Mar. 9, 2008), <http://www.washingtonpost.com/wp-dyn/content/article/2008/03/08/AR2008030802595.html> [<https://perma.cc/9N3E-F8P5>].

¹⁶⁰ *Id.*

¹⁶¹ *PV Recycling*, SOLAR ENERGY INDUS. ASS’N, <http://www.seia.org/policy/environment/pv-recycling> [<https://perma.cc/55N4-6Z6M>].

¹⁶² MULVANEY ET AL., *supra* note 156.

¹⁶³ *Id.*

¹⁶⁴ See John Vidal, *Toxic ‘E-Waste’ Dumped in Poor Nations, Says United Nations*, GUARDIAN (Dec. 14, 2013), <https://www.theguardian.com/global-development/2013/dec/14/toxic-ewaste-illegal-dumping-developing-countries> [<https://perma.cc/SCK2-5XR3>].

¹⁶⁵ The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (typically called The Basel Convention) is a global environmental treaty that “was adopted in 1989” to “protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes.” U.N. ENV’T PROGRAMME, THE BASEL CONVENTION AT A GLANCE, http://archive.basel.int/convention/bc_glance.pdf [<https://perma.cc/T3K7-38UE>].

South nations, it still happens at an alarming rate.¹⁶⁶ Hong Kong, China, Kenya, Taiwan, Pakistan, Thailand, Mexico, and the Dominican Republic are some of the dumping grounds for the computers, digital cameras, and smartphones that quickly become “obsolete” within a few years of their production.¹⁶⁷ Investigative reports that have tracked e-waste shipped from the United States to places like Guiyu, China, have revealed villagers without protective gear melting lead off of circuit boards, burning plastic from wires over coal-fired grills, and extracting gold from computer chips in large vats of hydrochloric acid.¹⁶⁸ Places like Guiyu have become contaminated wastelands; studies have found elevated levels of lead in children’s blood¹⁶⁹ and extremely high concentrations of cancer-causing polybrominated diphenyl ethers and dioxins in the soil.¹⁷⁰ In thirty to thirty-five years, when the large number of solar panels being installed today have exceeded their usable lifespans, there will be a tremendous solar e-waste problem if responsible and effective recycling programs are not enacted to protect Global South nations from further contamination.

A primary driver of the vast increase in solar PV panel installations has been their reduced cost: in 2016, solar panel installation cost 70% less than it did just seven years earlier in 2009.¹⁷¹ This has largely been due to the fact that in 2008, the Chinese government began providing large subsidies for solar companies, helping reduce the cost of manufacturing solar PV panels and increasing China’s solar panel manufacturing capacity tenfold. These subsidies caused a global oversupply that has

¹⁶⁶ See JIM PUCKETT ET AL., THE BASEL ACTION NETWORK & SILICON VALLEY TOXINS COAL., EXPORTING HARM: THE HIGH-TECH TRASHING OF ASIA 1–4 (2002), <https://static1.squarespace.com/static/558f1c27e4b0927589e0edad/t/56184364e4b0cf5700f852af/1444430692735/Exporting+Harm+Report.pdf> [<https://perma.cc/Q8X8-GY6X>]. The United States is the only industrialized nation that has not ratified the Basel Convention. *Id.* at 3.

¹⁶⁷ Katie Campbell & Ken Christensen, *Where Does America’s E-Waste End Up? GPS Tracker Tells All*, PBS NEWSHOUR (May 10, 2016), <http://www.pbs.org/newshour/updates/america-e-waste-gps-tracker-tells-all-earthfix> [<https://perma.cc/65ZQ-RYQS>].

¹⁶⁸ PUCKETT ET AL., *supra* note 166, at 1, 19–20.

¹⁶⁹ Xia Huo et al., *Elevated Blood Lead Levels of Children in Guiyu, an Electronic Waste Recycling Town in China*, 115 ENVTL. HEALTH PERSP. 1113, 1115–56 (2007); Pi Guo et al., *Blood Lead Levels and Associated Factors Among Children in Guiyu of China: A Population-Based Study*, 9 PLOS ONE 1, 5–7 (2014).

¹⁷⁰ Anna O.W. Leung et al., *Spatial Distribution of Polybrominated Diphenyl Ethers and Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in Soil and Combusted Residue at Guiyu, an Electronic Waste Recycling Site in Southeast China*, 41 ENVTL. SCI. & TECH. 2730 (2007).

¹⁷¹ Stone, *supra* note 151.

substantially driven down prices.¹⁷² However, the increased competition from Chinese manufacturers has meant that many of the companies in other countries that had previously operated with strict environmental standards—such as mandatory buy-back recycling programs for old solar panels—either went out of business or cut their recycling programs.¹⁷³ Recycling programs are critical for curbing the “looming tidal wave”¹⁷⁴ of end-of-life solar panels, because, as Associate Professor of Environmental Studies Dustin Mulvaney notes, while the solar industry generated about 60,000 tons of PV waste in 2015, by 2050, it will generate over 20 million tons of PV waste annually.¹⁷⁵ Without concerted efforts to enact policies that consider the environmental justice consequences of the expansion of solar energy, it is likely that the Global North pollution tragedy that is displaced onto Global South nations will be greatly exacerbated in three decades when the solar panels presently being installed have passed their usable lifespan.

There is a glimmer of hope, however. Beginning in 2014, under the amended Waste of Electrical and Electronic Equipment Directive (WEEE), solar producers that sell PV panels in the European Union are required to collect and recycle waste panels.¹⁷⁶ This extended producer responsibility (EPR) legislation has helped spur an infrastructure in the European Union for dealing with solar waste. For example, the collective compliance and waste management scheme PV Cycle developed a recycling process that achieves a 96% recycling rate for silicon-based PV modules, and even higher rates for non-silicon-based modules.¹⁷⁷ Enacting strong EPR policies at the federal level in the United States would create incentives for solar companies to design their PV panels in such a way that they would be “safer, easier and cheaper to recycle,” while also creating the infrastructure to

¹⁷² Usha C.V. Haley & George T. Haley, *How Chinese Subsidies Changed the World*, HARV. BUS. REV. (Apr. 25, 2013), <https://hbr.org/2013/04/how-chinese-subsidies-changed> [<https://perma.cc/5ARW-XL4G>]; Josh Harkinson, *The Solar Industry's New Dirty Secret*, MOTHER JONES (Aug. 19, 2013), <http://www.motherjones.com/blue-marble/2013/08/solar-industrys-new-dirty-secret> [<https://perma.cc/EC38-KHMX>].

¹⁷³ Harkinson, *supra* note 172.

¹⁷⁴ Dustin Mulvaney, *Act Now to Handle the Coming Wave of Toxic PV Waste* 2–3, SOLAR INDUS. MAG. (July 2015), http://solarindustrymag.com/online/issues/SI1507/FEAT_02_Act-Now-To-Handle-The-Coming-Wave-Of-Toxic-PV-Waste.html.

¹⁷⁵ *Id.* at 3.

¹⁷⁶ *PV Waste & Legislation*, SOLAR WASTE, <http://www.solarwaste.eu/pv-waste-legislation> [<https://perma.cc/BR78-H2F6>].

¹⁷⁷ *Breakthrough in PV Module Recycling*, PV CYCLE (Feb. 18, 2016), <http://www.pvcycle.org/press/breakthrough-in-pv-module-recycling/> [<https://perma.cc/Z7L6-3FWK>].

handle their recycling needs.¹⁷⁸ As Mulvaney asserts, the “rapid growth of PV installations means there is a limited window of opportunity to establish recycling policies and practices to manage end-of-life PV waste.”¹⁷⁹

Legislating renewable portfolio standards to spur the expansion of solar energy production in the United States has been lauded as a way to reduce dependence on fossil fuels and thereby fight climate change.¹⁸⁰ However, by not accounting for the environmental justice consequences of increased solar energy production—namely, the toxic waste that it will generate without mandatory recycling programs in place—the same pitfalls created by the Clean Air Act and its amendments may be repeated, wherein unintended consequences of the law will create environmental health harms for marginalized persons and groups.

CONCLUSION

As Sociology Professor Jill Lindsey Harrison argues in *Pesticide Drift and the Pursuit of Environmental Justice*, “environmental inequalities stem not only from a lack of knowledge, care, or political will but also from many actors’ attempts to do the right thing.”¹⁸¹ Unfortunately, attempts to improve the environment through legislation and regulation often happen without attention to possible unexpected outcomes for marginalized communities. As is apparent through the unintended consequences of the Clean Air Act in socially vulnerable communities in Central Appalachia, much harm can be done when wastes and other by-products of “environmental protection” are not considered. Industries will most often take the cheapest route to compliance, as is evidenced by the environmental justice “side-effects” created by the Clean Air Act presented above.¹⁸² Companies externalize their environmental costs onto those with the least ability to fight back—namely people of color, low-income communities, indigenous populations, and Global South nations. The massive scaling-up of solar energy production currently taking place around the world means that

¹⁷⁸ Mulvaney, *supra* note 174, at 6.

¹⁷⁹ *Id.*

¹⁸⁰ *Successful Strategies: Renewable Electricity Standards (2009)*, *supra* note 137.

¹⁸¹ JILL LINDSEY HARRISON, *PESTICIDE DRIFT AND THE PURSUIT OF ENVIRONMENTAL JUSTICE* 11 (2011).

¹⁸² See *supra* Part II.

if mandatory recycling policies are not implemented, it is likely that vast quantities of solar PV e-waste will be dumped on Global South nations when the usable lifespan of the solar panels currently being installed has passed. This “looming tidal wave”¹⁸³ of e-waste will exacerbate already significant environmental health injustices in Global South nations. In sum, the unintended consequences of policies aimed at improving environmental sustainability must be addressed if such policies are to be sustainable, beneficial, and just for *all*.

¹⁸³ Mulvaney, *supra* note 174, at 2.