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Article

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Plastic is now the most widely used human-made substance on the planet, and plastics pollution impacts marine and coastal ecosystems, local economies, and human health. Local and national governments are increasingly responding by banning plastic bags and other specific plastic products, taxing the use of certain plastics, and improving waste management and recycling. These are important steps, but alone they will not result in a meaningful reduction in cumulative plastics pollution or encourage development of sufficient alternatives to plastic. Additional policy measures are necessary.

This Article argues that climate change and plastic pollution share numerous similarities, and these similarities allow policymakers to benefit from the three decades of climate policy experimentation when choosing plastics pollution policy instruments. Both are collective action problems with local, national, and global impacts. Unilateral policies will do little to address total accumulation of the pollutant. There are countless sources of plastics pollution and the plastics have different uses and characteristics. Technological breakthroughs are necessary to recycle and reuse large amounts of plastics or reduce carbon pollution. There are influential, established interests in value chains that produce and use plastics or fuels that emit greenhouse gases.

The Article focuses on one key policy instrument in climate policies—pollution pricing—and identifies lessons from carbon pricing that can inform the design of plastics pollution policies. The Article begins by summarizing the global impacts of plastics pollution and the current international, national, and subnational plastics pollution policies. It then argues that broader market-based approaches can help address the global challenge of plastics pollution, identifies *policy design choices for market-based pollution policies, elaborates on the similarities between plastics pollution and climate change, and then describes lessons from climate policy that can inform the design of plastics policies. The Article concludes by describing the applicability of these lessons from climate change to the emerging policy response to plastic pollution.*

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Pricing Plastics Pollution: Lessons from Three Decades of Climate Policy

JONAS J. MONAST [*] & JOHN VIRDIN [**]

INTRODUCTION

Plastic is now the most widely used human-made substance on the planet.[1] An estimated 8.3 billion tons of plastics have been produced worldwide, resulting in an estimated 6.3 billion tons of plastic waste.[2] The vast majority of the waste is disposed of in landfills or discarded into the natural environment.[3] A recent study estimates that 1.3 billion tons of plastics will pollute land and oceans by 2040 unless there is a global response.[4]

Plastics pollution is a global collective action problem with local, national, and international implications.[5] Pollution impacts marine and coastal ecosystems, local economies, and human health.[6] Local and national governments are increasingly responding by banning plastic bags and other

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[1] Boris Worm et al., *Plastic as a Persistent Marine Pollutant*, 42 ANN. REV. ENV'T & RES. 1, 2 (2017) ("[P]lastics are now the most widely used man-made substances and have become omnipresent in every aspect of our lives.").

[2] Roland Geyer, Jenna R. Jambeck & Kara Lavender Law, *Production, Use, and Fate of All Plastics Ever Made*, 3 SCI. ADVANCES, July 19, 2017, at 1, 1, https://www.science.org/doi/epdf/10.1126/sciadv.1700782. To put the amount of plastics in perspective, the BBC estimates that "8.3 billion tonnes is as heavy as 25,000 Empire State Buildings . . . or a billion elephants." Jonathan Amos, *Earth Is Becoming 'Planet Plastic'*, BBC (July 19, 2017), https://www.bbc.com/news/science-environment-40654915.

[3] Amos, *supra* note 2.

[4] Victoria Gill, *Plastic Pollution to Weigh 1.3 Billion Tonnes by 2040*, BBC (July 23, 2020), https://www.bbc.com/news/science-environment-53521001. *See also* Winnie W. Y. Lau et al., *Evaluating Scenarios Toward Zero Plastic Pollution*, 369 SCI., Sept. 18, 2020, at 1, 1, https://www.science.org/doi/pdf/10.1126/science.aba9475?casa_token=DGmYm9m4Ef8AAAAA:bEFnJdjv1YJi0Izr5vQxNhJZLI0ne1JBrp_8ZEIKTf4xF6Zxtyvhroy3OhjAKdIUU41hieLQY1NtT-E (stating that, "[i]f plastic production and waste generation continue to grow at current rates, the annual mass of mismanaged waste has been projected to more than double by 2050"). Pollution is a shared problem where rational individual decisions lead to collective outcomes that are sub-optimal or, in economic terms, a market failure. Peter Kollock, *Social Dilemmas: The Anatomy of Cooperation*, 24 ANN. REV. SOCIO. 183, 183 (1998).

[5] Nicola J. Beaumont et al., *Global Ecological, Social and Economic Impacts of Marine Plastic*, 142 MARINE POLLUTION BULL. 189, 189 (2019) ("The impact of marine plastic is . . . a global issue . . . .").

[6] *See* Philip J. Landrigan et al., *Human Health and Ocean Pollution*, 86 ANNALS GLOB. HEALTH 151, 152 (2020) (presenting research findings on the effects of pollution on the environment, ecosystem, and human health).

specific plastic products, taxing the use of certain plastic products, and improving waste management and recycling.[7] In 2019, almost all countries agreed to a first international step to limit plastic waste by adding plastic waste to the Basel Convention that limits the international transfer of certain types of hazardous waste.[8] Current local and national policies are important steps, but alone they will not result in a meaningful reduction in cumulative plastics pollution or encourage development of sufficient alternatives to plastic.[9] Additional policy measures are necessary.

This Article focuses on one key policy instrument to combat plastic pollution—pollution pricing—and identifies lessons that can inform the design of policy responses. Pollution pricing requires firms to internalize the social and environmental impacts of pollution via taxes, levies, fees, or cap-and-trade programs. Depending on the price, market-based policies can shift market dynamics in favor of less polluting alternatives, incentivize behavior changes, and generate revenue for policymakers to invest in technology innovation or mitigation.[10] They can also allow multiple jurisdictions to link their policies, resulting in a broader scope without requiring multilateral agreement before taking action.[11]

To date, policymakers have used economic instruments such as pollution pricing in limited circumstances, largely in the form of fees or taxes to combat pollution from plastic carrier bags. These policies typically do not set the price based on estimated social cost; rather, they impose a relatively small fee that may serve as nudges to influence consumer behavior but do little to reduce the volume of plastics pollution. Although regulatory bans are far more prevalent, an increasing number of local and national governments are proposing pollution taxes.[12]

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[7] Giulia Carlini & Konstantin Kleine, *Advancing the International Regulation of Plastic Pollution Beyond the United Nations Environment Assembly Resolution on Marine Litter and Microplastics*, 27 REV. EUR. COMPAR. & INT'L ENV'T L. 234, 234–35 (2018); Dirk Xanthos & Tony R. Walker, *International Policies to Reduce Plastic Marine Pollution from Single-Use Plastics (Plastic Bags and Microbeads): A Review*, 118 MARINE POLLUTION BULL. 17, 17–21 (2017).

[8] *Overview*, BASEL CONVENTION, http://www.basel.int/Implementation/MarinePlasticLitterandMicroplastics/Overview/tabid/6068/Default.aspx (last visited Nov. 13, 2021).

[9] KAREN RAUBENHEIMER & NIKO URHO, POSSIBLE ELEMENTS OF A NEW GLOBAL AGREEMENT TO PREVENT PLASTIC POLLUTION 9 (2020), https://pub.norden.org/temanord2020-535/temanord2020-535.pdf (calling for "a global response that extends beyond waste management to address the entire life cycle of plastic pollution" because "[a] business-as-usual approach that does not address current governance gaps is harmful to ecosystems and the services they provide, as well as harmful to social well-being and economic productivity in multiple sectors").

[10] Jonas Monast, *From Top-Down to Bottom-Up Climate Policy: New Challenges in Carbon Market Design*, 8 SAN DIEGO J. CLIMATE & ENERGY L. 175, 180 (2017).

[11] *Id.*

[12] *See* Francisco Alpizar et al., *A Framework for Selecting and Designing Policies to Reduce Marine Plastic Pollution in Developing Countries*, 109 ENV'T SCI. & POL'Y 25, 27–29 (2020) (surveying international plastics pollution policies).

Designing effective national or international pricing policies for plastics pollution requires multiple regulatory choices, such as deciding what is subject to the price, where in the value chain to apply the price, and what pricing instrument to use. Because there is limited experience with plastics pollution pricing beyond fees or taxes on single-use bags, policymakers interested in designing a market-based policy to limit plastics pollution must look to other pollution pricing regimes for models to help guide policy design. Here, climate policy can serve as a model for considering market design options and tradeoffs. Markets and pricing instruments have played a central role in the three-decade effort to develop effective national and international greenhouse gas (GHG) policies.[13]

Like plastics pollution, climate change is a global problem with planetary-scale effects.[14] Unilateral policies will do little to address total accumulation of the pollutants. Both problems arise from multiple and diffuse types and sources of pollutants, with different characteristics and damage curves, and heterogenous abatement costs. There are countless sources of plastics pollution, and the plastics have different uses and characteristics. Most sectors of the economy are responsible for major emissions and are increasingly dependent upon plastics for packaging and products, as well as GHG-emitting fossil fuels for energy. GHG emissions are pervasive throughout the global economy.[15] Different GHGs have different heat trapping potential and persist in the atmosphere for different periods of time.[16] Climate policies may focus on all pollutants, some pollutants (usually carbon dioxide (CO_2)), some sectors, or some regions.[17]

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[13] *See* Monast, *supra* note 10, at 180 (citing U.S. and international emissions trading programs).

[14] Jonathan B. Wiener, *Property and Prices to Protect the Planet*, 19 DUKE J. COMPAR. & INT'L L. 515, 516 (2009).

[15] *See Sources of Greenhouse Gas Emissions*, U.S. ENV'T PROT. AGENCY: GREENHOUSE GAS EMISSIONS, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (July 27, 2021) (summarizing emission impacts from different sectors of the U.S. economy). Sources of GHG emissions range from major emitters, such as industrial facilities, power plants, and oil and natural gas extraction, to smaller emitters, such as individual motor vehicles and gas-fired appliances. *Id.*

[16] A molecule of carbon dioxide (CO_2), the most prevalent GHG, has relatively minor heat trapping potential compared to other GHGs, but it persists in the atmosphere for over a century. *See Understanding Global Warming Potentials*, U.S. ENV'T PROT. AGENCY: GREENHOUSE GAS EMISSIONS, https://www.epa.gov/ghgemissions/understanding-global-warming-potentials (Sept. 9, 2020) (comparing the heat-trapping potential of different GHGs). Methane, by contrast, has approximately twenty-five times the heat trapping potential of CO_2, but it only lasts in the atmosphere for about ten years. *Importance of Methane*, U.S. ENV'T PROT. AGENCY: GLOB. METHANE INITIATIVE, https://www.epa.gov/gmi/importance-methane (June 30, 2021); *Greenhouse Gases*, MIT CLIMATE PORTAL, https://climate.mit.edu/explainers/greenhouse-gases (last visited Nov. 13, 2021).

[17] *See, e.g.*, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, 81 Fed. Reg. 35,824 (June 3, 2016) (to be codified at 40 C.F.R. pt. 60) (establishing GHG emission standards for oil and gas wells); Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324 (May 7, 2010) (to be codified at 40 C.F.R. pts. 85, 86, 600) (limiting GHG emissions from light-duty motor vehicles); *see also Cap-and-Trade Program: About*, CAL. AIR RES. BD., https://ww2.arb.ca.gov/our-work/programs/cap-

Policies targeting multiple GHGs use the heat-trapping potential of CO_2 to develop a common metric for measuring compliance. Similarly, different plastics serve different purposes, have different levels of recyclability and reuse, and have different lifespans. Each of these types of plastics have different characteristics and serve different purposes. As a result, reducing plastic pollution and mitigating climate change are more complex than targeting a single type of pollutant, product, or even economic sector.

The Article begins by summarizing the global impacts of plastics pollution and the current international, national, and subnational plastics pollution policies. It then argues that broader market-based approaches can help address the global challenge of plastics pollution. This section identifies policy design choices for market-based pollution policies before elaborating on the similarities between plastics pollution and climate change and exploring the lessons from climate policy that can inform the design of plastics policies. The Article concludes by describing the applicability of these lessons from climate change to the emerging policy response to plastic pollution.

I. THE GLOBAL PROBLEM OF PLASTICS POLLUTION

Worldwide plastics production has increased exponentially in recent decades. Cumulatively, there were 7.8 billion tons of plastics produced between 1950 and 2015, with half of this amount produced between 2002 and 2015.[18] Production has increased from 2 million tons in 1950 to 380 million tons in 2015.[19]

Plastics are polymers synthesized from petrochemicals or, far less frequently, from biomass raw materials. The resin is easily molded into a large variety of different shapes and products, most of which are not biodegradable.[20] Common types of plastic resin include: polyethylene (PE), used for packaging, carryout bags, film packaging, milk jugs, and detergent and water bottles, among others; polypropylene (PP), used for carpet fibers, automotive bumpers, appliances, drinking straws, bottle caps, and yogurt containers, among others; and polyethylene terephthalate (PET), used for food and beverage packaging, utensils, plates, disposable cups, plastic tableware, food containers, and packaging foam (e.g., Styrofoam), among others.[21] Of these uses of plastic material, packaging is far and away the most common, constituting an estimated 36% of global primary plastic production

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and-trade-program/about (last visited Nov. 18, 2021) (detailing a statewide carbon market covering approximately 80% of the state's GHG emissions).

[18] Geyer, Jambeck & Lavender Law, *supra* note 2, at 1; Worm et al., *supra* note 1, at 1.

[19] Geyer, Jambeck & Lavender Law, *supra* note 2, at 1.

[20] Worm et al., *supra* note 1, at 2; Geyer, Jambeck & Lavender Law, *supra* note 2, at 1.

[21] RACHEL KARASIK ET AL., 20 YEARS OF GOVERNMENT RESPONSES TO THE GLOBAL PLASTIC POLLUTION PROBLEM: THE PLASTICS POLICY INVENTORY 127 (2020), https://nicholasinstitute.duke.edu/publications/20-years-government-responses-global-plastic-pollution-problem.

and 47% of the total global waste generated from primary plastics in 2015.[22] This volume reflects a global shift from reusable to single-use containers.[23]

Annual plastic waste is expected to roughly track annual plastic resin production. An influential 2015 study estimated that plastics constituted approximately 11% of total global waste generated in 2010.[24] This waste is typically disposed of through either: (1) recycling or reprocessing (accounting for 18% of non-fiber plastic waste in 2014), (2) thermal incineration (accounting for 24% of non-fiber plastic waste in 2014), or (3) managed systems such as sanitary landfills.[25] Plastic "leakage" occurs when plastic is not disposed of but left uncontained in the environment during any stage of a product's life cycle. Most commonly, plastics pollution results from mismanagement of waste.[26] This leakage or pollution into the environment is often monitored by the size of the plastics, typically categorized as either macroplastics (200 micrometers or greater in diameter) or microplastics.[27]

Microplastics may be produced deliberately, such as plastic beads used in personal care products, or they may result from larger plastic products breaking down, such as rubber particles from tire abrasion.[28] They are a particular case of mis-managed plastic waste that may enter the environment via wastewater, when personal care products containing microplastic beads are applied, rinsed, and washed down the drain into a wastewater stream. Due to their size, a portion of microplastics remain in the final effluent even after treatment.[29] Microplastics may also enter the environment at the plastic production stage in the form of "pellets, spherules, granules, discs, etc." that leak from processing plants or during transport.[30]

Plastic leakage into the environment often enters waterways and ocean and coastal ecosystems, where biophysical breakdown is slow and the

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[22] Geyer, Jambeck & Lavender Law, *supra* note 2, at tbl.S5.

[23] *Id.* at 1.

[24] Jenna R. Jambeck et al., *Plastic Waste Inputs from Land into the Ocean*, 347 SCI. 768, 770 (2015).

[25] Geyer, Jambeck & Lavender Law, *supra* note 2, at 2–3.

[26] Worm et al., *supra* note 1, at 5–6; Geyer, Jambeck & Lavender Law, *supra* note 2, at 3.

[27] Worm et al., *supra* note 1, at 8, 15.

[28] Richard C. Thompson, *Microplastics in the Marine Environment: Sources, Consequences and Solutions*, *in* MARINE ANTHROPOGENIC LITTER 185, 185, 187 (Melanie Bergmann, Lars Gutow & Michael Klages eds., 2015).

[29] Jason P. McDevitt et al., *Addressing the Issue of Microplastics in the Wake of the Microbead-Free Waters Act—A New Standard Can Facilitate Improved Policy*, 51 ENV'T SCI. & TECH. 6611, 6612 (2017); David A. Strifling, *The Microbead-Free Waters Act of 2015: Model for Future Environmental Legislation, or Black Swan?*, 32 J. LAND USE & ENV'T L. 151, 152, 155 (2016).

[30] Aaron Lechner & David Ramler, *The Discharge of Certain Amounts of Industrial Microplastic from a Production Plant into the River Danube Is Permitted by the Austrian Legislation*, 200 ENV'T POLLUTION 159, 159 (2015).

material persists, with relatively few feasible options for cleanup.[31] Microplastics in particular, as a result of breakdown from larger plastic products, are widespread in marine ecosystems.[32] The volume of mismanaged plastic waste entering the oceans from inland waterways, wastewater outflows, and transport by wind or tides was first estimated to be on the order of 4.8 to 12.7 million tons in 2010,[33] and the total volume entering all aquatic ecosystems (both freshwater and marine) was subsequently estimated to be on the order of 19 to 23 million tons in 2016.[34] Of the total plastic waste entering the oceans, the amount transported via rivers is significant, and estimated to be on the order of 1.2 to 2.4 million tons annually.[35]

The estimated total weight of plastic floating on the surface of the world's oceans is between 93,000 and 267,000 tons—an order of magnitude lower than amounts estimated to enter marine ecosystems.[36] One hypothesis for this "missing plastic" was that most plastic entering the ocean settled below the surface after a relatively short period.[37] More recently, a hypothesis to explain this missing plastic suggests that the shoreline is capturing a major part, where an estimated two-thirds of the mass of buoyant macroplastics entering the ocean since 1950 is stored (i.e., stranded, settled and/or buried, in episodes of capturing and resurfacing).[38]

Single-use plastic packaging, commonly polyethylene used in food packaging and designed for immediate disposal, is a major cause of global plastics pollution.[39] While the types of plastic products are diverse, "plastics' largest market is packaging, an application whose growth was accelerated by a global shift from reusable to single-use containers."[40] Packaging is by far the largest use of plastics by volume and more than double the next most

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[31] Laurent Lebreton, Matthias Egger & Boyan Slat, *A Global Mass Budget for Positively Buoyant Macroplastic Debris in the Ocean*, 9 SCI. REPS., Sept. 12, 2019, at 1, 1–2, 7, 9, https://www.nature.com/articles/s41598-019-49413-5.pdf; Worm et al., *supra* note 1, at 2, 9–10.

[32] Richard C. Thompson et al., *Lost at Sea: Where Is All the Plastic?*, 304 SCI. 838, 838 (2004).

[33] Jambeck et al., *supra* note 24, at 768.

[34] Stephanie B. Borrelle et al., *Predicted Growth in Plastic Waste Exceeds Efforts to Mitigate Plastic Pollution*, 369 SCI., Sept. 18, 2020, at 1, 1, https://www.science.org/doi/pdf/10.1126/science.aba3656?casa_token=KsYTBpftkYYAAAAA:6zJuCpIwDDSuQwUbAbm42KBrh6hn1AW8WE4PTR5-ySZoDwAcdJzlgV3bhlRUQJzeGizYmPPGssprAdY.

[35] Laurent C.M. Lebreton et al., *River Plastic Emissions to the World's Oceans*, 8 NATURE COMMC'NS, June 7, 2017, at 1, 3, https://www.nature.com/articles/ncomms15611.pdf.

[36] Lebreton, Egger & Slat, *supra* note 31, at 8.

[37] Albert A. Koelmans et al., *All Is Not Lost: Deriving a Top-Down Mass Budget of Plastic at Sea*, 12 ENV'T RSCH. LETTERS, Nov. 10, 2017, at 1, 1, 7–8, https://iopscience.iop.org/article/10.1088/1748-9326/aa9500/pdf.

[38] Lebreton, Egger & Slat, *supra* note 31, at 2–3.

[39] *See* Laura Parker, *The World's Plastic Pollution Crisis Explained*, NAT'L GEOGRAPHIC (June 7, 2019), https://www.nationalgeographic.com/environment/article/plastic-pollution (explaining the role of single-use plastics in the global plastic pollution crisis).

[40] Geyer, Jambeck & Lavender Law, *supra* note 2, at 1.

common use (building and construction).[41] In total, plastics packaging accounted for 47% of the total global waste generated from primary plastics that same year.[42] The contribution to plastic waste volumes reflects a shift over the last few decades from reusable containers to single-use plastic packaging as a method for delivering products to customers, and has led some environmental non-governmental organizations to call for large consumer goods companies to reduce the number of plastic packaging items they produce by 50% by 2025.[43] A range of solutions has been proposed to make progress towards such ambitious targets, all revolving around strategies to produce less virgin plastic packaging, e.g., eliminating packaging items, increasing reuse of packaging, and reducing the materials circulating (i.e., recycling and composting).[44] However, governments are still experimenting with policy instruments to create requirements or incentives for such solutions to plastic packaging pollution,[45] and many laws and regulations have focused solely on plastic carrier bags, typically targeting the product and not the virgin plastic content.[46]

Projections about the future scale of global plastic pollution are daunting. If global plastic production continues its exponential growth, humanity will have produced 34 billion metric tons of plastics (including resins, polyester polyamide and acrylic fibers, and additives) by the end of 2050, of which 12 billion tons would be discarded in landfills or the natural environment assuming consistent use patterns and current global waste management trends.[47] One widely-cited study finds that the amount of plastic waste entering marine ecosystems could grow by an order of magnitude between 2010 and 2025 based on current trends in waste management.[48] Another study finds that a business-as-usual (BAU) approach to waste management could result in 90 million tons of plastic waste entering the world's freshwater and marine ecosystems annually by

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[41] *Id.* Plastic packaging accounted for 42% of global primary production of nonfiber plastics in 2015. *Id.* The sector with the next largest use—building and construction—accounted for "19% of all nonfiber plastics." *Id.*

[42] *Id.* at tbl.S5 (summarizing the total primary waste generation in 2015, with packaging accounting for 141 million metric tons out of a total of 302 million metric tons).

[43] #BREAKFREEFROMPLASTIC, BRANDED VOLUME III: DEMANDING CORPORATE ACCOUNTABILITY FOR PLASTIC POLLUTION 48 (2020).

[44] ELLEN MACARTHUR FOUND., UPSTREAM INNOVATION: A GUIDE TO PACKAGING SOLUTIONS 6–7 (2020).

[45] *See generally* KARASIK ET AL., *supra* note 21, at 32–79 (summarizing domestic and international policies to reduce plastics pollution). Duke University's Nicholas Institute for Environmental Policy Solutions maintains a database of over 500 laws and regulations to track developments in plastics pollution policies. *Plastics Policy Inventory*, NICHOLAS INST. FOR ENV'T POL'Y SOLS. (R. Karasik, J. Virdin, A. Pickle & J. Wilson eds., 2021), https://nicholasinstitute.duke.edu/plastics-policy-inventory.

[46] Xanthos & Walker, *supra* note 7, at 19–21, 20–21 tbl.1.

[47] Geyer, Jambeck & Lavender Law, *supra* note 2, at 3.

[48] Jambeck et al., *supra* note 24, at 768.

2030.[49] In this model, even under an "ambitious" scenario where all current plastic pollution reduction commitments are implemented, the amount of plastic waste entering the world's aquatic ecosystems is predicted to remain at or exceed 2016 levels in 2030.[50] Another global model suggests that the BAU scenario could result in a total volume of plastic pollution (aquatic and terrestrial) on the order of 81 million tons annually by 2040.[51] This model projects that implementing all feasible interventions in a scenario of "systemic change" would only reduce the total volume of plastic pollution by 40% in 2040, compared to 2016 rates.[52]

The plastic pollution problem is global in scale, but heterogenous consumption and waste disposal patterns have resulted in very different national contributions to the problem. Countries in Asia accounted for just over half of global plastic production in 2018 (with China as the world's leading producer at 30%),[53] and 20 countries were estimated to contribute 83% to the total volume of plastic waste entering the ocean in 2010 (and China, Indonesia, Philippines, Vietnam and Sri Lanka accounted for over half of these estimates).[54] Similarly, an estimated 86% of the plastic pollution reaching the ocean via rivers occurred on the continent of Asia,[55] which has been characterized as the epicenter of the global problem.[56] However, recent estimates suggest that the United States was the world's largest national producer of plastic waste in 2016 (42 million tons), and the world's largest contributor to plastic pollution when exported waste is included.[57]

There is no single solution to the global plastic pollution problem. Systemic change is needed across all stages of plastic product life cycles and at multiple levels from local to global.[58] For example, waste management is fundamental to solving the problem,[59] though it occurs at local levels with very different capacities around the world, often correlated to national income.[60] However, the global effort to reduce plastic pollution cannot rely on waste management capacity alone but will require "a fundamental

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[49] Borrelle et al., *supra* note 34, at 2.

[50] *Id.*

[51] Lau et al., *supra* note 4, at 2–3.

[52] *Id.* at 2, 4.

[53] PLASTICSEUROPE, PLASTICS–THE FACTS 2019: AN ANALYSIS OF EUROPEAN PLASTICS PRODUCTION, DEMAND AND WASTE DATA 15 (2019), https://plasticseurope.org/wp-content/uploads/2021/10/2019-Plastics-the-facts.pdf.

[54] Jambeck et al., *supra* note 24, at 769 tbl.1, 770.

[55] Lebreton et al., *supra* note 35, at 3.

[56] Beatriz Garcia, Mandy Meng Fang & Jolene Lin, *Marine Plastic Pollution in Asia: All Hands on Deck!*, 3 CHINESE J. ENV'T L. 11, 11–12 (2019).

[57] Kara Lavender Law et al., *The United States' Contribution of Plastic Waste to Land and Ocean*, 6 SCI. ADVANCES, Oct. 30, 2020, at 1, 1, https://www.science.org/doi/pdf/10.1126/sciadv.abd0288.

[58] Lau et al., *supra* note 4, at 1, 6.

[59] Jambeck et al., *supra* note 24, at 768, 770.

[60] SILPA KAZA ET AL., WHAT A WASTE 2.0: A GLOBAL SNAPSHOT OF SOLID WASTE MANAGEMENT TO 2050 1–2 (2018).

transformation of the plastic economy" based on circular economy principles where end-of-life plastic products are valued and reused, unless growth in production and use is halted.[61]

While the transformations and systemic change required to have a global impact on the plastic pollution problem require differentiated responses at multiple levels around the world, in aggregate the scale of the problem has led to calls for global collective action.[62] Designing and implementing these policies requires recognizing that plastics pollution is simultaneously an economic, technical, and behavioral challenge.

Plastics are often less costly than other options and virgin plastics are less expensive to produce than recycled plastics.[63] Some companies are committing to utilize recycled plastics despite their higher costs.[64] While consumer demand and activist pressure has influenced decision-making at some companies, in general, plastics manufacturers and consumers externalize the environmental impacts of plastics.[65] This can reduce incentives for innovation to improve recycling and develop alternatives with lower environmental impacts.

Economics is not the only explanation for the dramatic increase in plastics production or the challenges with managing the waste. There are multiple types of plastic, each with different characteristics, uses, and environmental impacts.[66] Some categories are recyclable, many are not.

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[61] Borrelle et al., *supra* note 34, at 3.

[62] Marcus Haward, *Plastic Pollution of the World's Seas and Oceans as a Contemporary Challenge in Ocean Governance*, 9 NATURE COMMC'NS, Feb. 14, 2018, at 1, 2, https://www.nature.com/articles/s41467-018-03104-3.pdf.

[63] Jillian Ambrose, *War on Plastic Waste Faces Setback as Cost of Recycled Material Soars*, GUARDIAN (Oct. 13, 2019), https://www.theguardian.com/environment/2019/oct/13/war-on-plastic-waste-faces-setback-as-cost-of-recycled-material-soars (describing how the cost of plastic recycling impacts European pollution abatement policies); Eric Onstad, *Plastic Bottles vs. Aluminum Cans: Who'll Win the Global Water Fight?*, REUTERS, https://www.reuters.com/article/us-environment-plastic-aluminium-insight-idUSKBN1WW0J5 (Oct. 17, 2019, 2:05 AM) ("Simple economics is a major factor; aluminum is more expensive than plastic—the raw material cost for a can is about 25–30% higher than a PET bottle of a similar volume . . . .").

[64] For example, Coca-Cola, a company that has faced high-profile critiques of its contribution to plastics pollution, has set a goal of producing zero plastics waste by 2030, and it recently announced plans to test a new paper bottle technology. *Coca-Cola Company Trials First Paper Bottle*, BBC (Feb. 12, 2021), https://www.bbc.com/news/technology-56023723. Though not a binding commitment, it is an example of a company responding to consumer pressure.

[65] For example, the 2020 annual audit of #breakfreefromplastic earned international headlines when it identified the top ten global brands responsible for plastics pollution. Rachel Koning Beals, *Coca-Cola, PepsiCo and Nestlé Top '10 Worst Plastic Polluters' of 2020*, MARKETWATCH (Dec. 8, 2020, 5:17 PM), https://www.marketwatch.com/story/coca-cola-pepsico-and-nestle-top-10-worst-plastic-polluters-of-2020-11607465840. *See also* Blasiak et al., *Corporations and Plastic Pollution: Trends in Reporting*, 3 SUSTAINABLE FUTURES, Oct. 21, 2021, at 1, 3, https://doi.org/10.1016/j.sftr.2021.100061 (finding that "consumer pressure may already be driving attention to plastics issues" among consumer goods and technology companies).

[66] The seven categories of plastics include PET, PP, high-density polyethylene (HDPE), polyvinyl chloride (PVC or "vinyl"), low-density polyethylene (LDPE), polystyrene (PS or Styrofoam), and other

Conventional plastics are not biodegradable or compostable. Plastics break down into smaller parts, but the remaining microplastics can remain in the environment for centuries.[67] Some types of plastics, such as plastic films or plastic bags, can interfere with the ability to recycle other forms of plastics if they are combined.[68] Alternatives, such as compostable or biodegradable plastic offer environmental benefits but require proper management.[69] Compostable plastics, for example, are only compostable at industrial facilities and are not recyclable with conventional plastics.[70]

The flexibility, durability, and disposability of resins make them superior technical options for some uses. This is particularly apparent with the increase in plastic waste during the COVID-19 pandemic, when plastics allowed cheap and quick production of protective equipment, medical supplies, and single-use serving implements that have been critical for protecting public health.[71] Reducing plastics waste requires new alternatives that provide the same benefits.

There is also a critical behavioral aspect to limiting plastics pollution, particularly with plastic packaging and single-use plastics. In many circumstances, plastics are convenient and cheap. As companies increasingly rely on plastic packaging, consumers may have limited options to choose alternatives. Consumers may not have a choice between a product with virgin plastic packaging or a similar product with other packaging. Instead, the only choice may be purchasing the product with plastic packaging or avoiding that type of product altogether.

Effective recycling is an important part of the solution, but this requires enhanced education regarding which plastics are accepted. Consumer

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plastics. Tod Hardin, *Plastic: It's Not All the Same*, PLASTIC OCEANS (Feb. 23, 2021), https://plasticoceans.org/7-types-of-plastic/.

[67] Stephan Kubowicz & Andy M. Booth, *Biodegradability of Plastics: Challenges and Misconceptions*, 51 ENV'T SCI. & TECH. 12058, 12058 (2017) ("The fragmentation of the material into increasingly smaller pieces is an unavoidable stage of the degradation process. Ultimately, plastic materials degrade to micron-sized particles (microplastics), which are persistent in the environment and present a potential source of harm for organisms.").

[68] *Plastic Bag/Film Recycling During the Pandemic*, MINN. POLLUTION CONTROL AGENCY (May 1, 2020), https://www.pca.state.mn.us/featured/plastic-bagfilm-recycling-during-pandemic.

[69] Thomas Neitzert, *Why Compostable Plastics May Be No Better for the Environment*, CONVERSATION (Aug. 2, 2018, 3:53 AM), https://theconversation.com/why-compostable-plastics-may-be-no-better-for-the-environment-100016.

[70] *Frequently Asked Questions About Plastic Recycling and Composting*, U.S. ENV'T PROT. AGENCY: TRASH-FREE WATERS, https://www.epa.gov/trash-free-waters/frequently-asked-questions-about-plastic-recycling-and-composting (July 30, 2020).

[71] Michelle Nowlin et al., *Policy in the Pandemic: Are Governments Pushing the Pause Button on Responses to Plastic Pollution?*, NICHOLAS INST. FOR ENV'T POL'Y SOLS. (July 27, 2020), https://nicholasinstitute.duke.edu/articles/policy-pandemic-are-governments-pushing-pause-button-responses-plastic-pollution; Rob Picheta, *Coronavirus Is Causing a Flurry of Plastic Waste. Campaigners Fear It May Be Permanent*, CNN, https://www.cnn.com/2020/05/04/world/coronavirus-plastic-waste-pollution-intl/index.html (May 4, 2020, 6:17 AM).

demand can expand markets for recycled plastic products if the consumers are able to evaluate claims about pre- and post-consumer content, but cost and convenience may still eclipse interest in recycled content. Other behavioral changes, such as purchasing products with less plastic packaging or reducing consumption of single-use plastics, can also increase market demand for alternatives to plastics. This depends on availability of alternatives to send the market signal.

II. THE STATE OF PLASTICS POLLUTION POLICY

Governments around the world have responded to plastic pollution at multiple levels: from international efforts, such as resolutions at the United Nations Environment Assembly (UNEA), to national and subnational efforts, such as plastic product bans, taxes, or fees.[72] The number of global, regional, national, and subnational policies targeting plastics pollution has increased significantly over the last decade.[73] While more comprehensive policies are emerging, the majority to date have been focused on a discrete location or a particular type of single-use plastics, such as plastic bags.[74]

This Part summarizes policies in place at the international, national, and subnational levels. The policy instruments fall into three categories. Regulatory instruments include requirements to capture post-consumer waste, stewardship practices, limits or bans for specific types of plastics, and prohibitions on pollution.[75] Economic instruments include subsidies,

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[72] Carlini & Kleine, *supra* note 7, at 234–42. A growing number of global and regional reviews have been conducted to attempt to study these policy responses. *See, e.g.*, C. Andrea Clayton et al., *Policy Responses to Reduce Single-Use Plastic Marine Pollution in the Caribbean*, 162 MARINE POLLUTION BULL., Nov. 16, 2020, at 1, 1, https://doi.org/10.1016/j.marpolbul.2020.111833 (reviewing policies to limit plastic pollution in Caribbean countries); Issahaku Adam et al., *Policies to Reduce Single-Use Plastic Marine Pollution in West Africa*, 116 MARINE POL'Y, Mar. 19, 2020, at 1, 1, https://doi.org/10.1016/j.marpol.2020.103928 (reviewing West Africa's approach to single-use plastic reduction); Riley E.J. Schnurr et al., *Reducing Marine Pollution from Single-Use Plastics (SUPs): A Review*, 137 MARINE POLLUTION BULL. 157, 157 (2018) (identifying "new multi-jurisdictional legislative interventions to reduce [single-use plastics] since 2017"); U.N. ENV'T PROGRAMME, LEGAL LIMITS ON SINGLE-USE PLASTICS AND MICROPLASTICS: A GLOBAL REVIEW OF NATIONAL LAWS AND REGULATIONS 3–4 (2018) [hereinafter UNEP SINGLE-USE PLASTICS REPORT] (categorizing plastics pollution policy instruments and identifying the number of countries that have adopted a respective instrument); Xanthos & Walker, *supra* note 7, at 17 (reviewing "international market-based strategies and policies to reduce plastic bags and microbeads"); Jennifer Clapp & Linda Swanston, *Doing Away with Plastic Shopping Bags: International Patterns of Norm Emergence and Policy Implementation*, 18 ENV'T POL. 315, 315 (2009) (examining international adoption of anti-plastic bag policies).

[73] *Plastics Policy Inventory*, *supra* note 45. The Nicholas Institute for Environmental Policy Solutions plastics pollution tracker excludes generally applicable policies that can have a significant effect on plastics pollution but are not explicitly designed to address plastics (e.g., general solid waste management policies). *Id.*

[74] UNEP SINGLE-USE PLASTICS REPORT, *supra* note 72, at 3–4.

[75] KARASIK ET AL., *supra* note 21, at 27–28. There are wide disparities in the use of these instruments. The Karasik et al. study found that national governments were more "likely to use a regulatory instrument to ban plastic bags in some form . . . [than] they were to use an economic instrument

payments for returning plastic waste, tax breaks, and taxes or fees on certain products (e.g., plastic bags) or post-consumer plastic waste.[76] Information instruments include record-keeping, data reporting, education, and labels or placards.[77] This Part concludes with a discussion of the impact of climate policy on plastics pollution.

A. *International Policies*

Prior to 2000, international policies applicable to plastic pollution were largely binding multilateral environmental agreements that only addressed maritime sources.[78] Since 2000, twenty-eight international policies have addressed the plastic pollution problem at the global level, typically through non-binding agreements focused on land-based sources[79] of macroplastic pollution.[80] International efforts started to focus on different types of pollutants in more specific terms following the 2011 Honolulu Strategy,[81] a non-binding agreement that aims to reduce the "amount and impact of land-based sources of marine debris[;] . . . [the] amount and impact of sea-based sources of marine debris[;] . . . [and the] amount and impact of accumulated marine debris on shorelines," coastal habitats, and waters.[82] The instruments used in these policies typically include support for "research and monitoring, and calls for states to develop national action plans"—essentially plans or recommendations to develop more specific national-level instruments in the future.[83] While helping to elevate the problem of plastic pollution on the international policy agenda, as well as developing guidance and commitments for planning national policies, few binding commitments have been made or specific targets set.[84]

As a result, experts and scholars have identified the lack of a globally-agreed, "binding, specific and measurable" target to reduce plastic

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such as a tax or a levy . . . ." *Id.* at 69. Furthermore, "[w]hile bans were used more frequently to address plastic bag pollution in the inventory, lower income states were more likely to use bans than higher income states, where economic instruments were more likely to be deployed." *Id.*

[76] *Id.* at 27–28.

[77] *Id.* at 28.

[78] *Id.* at 7.

[79] *Id.*

[80] *Id.* at 8.

[81] *Id.* at 34–35, 105.

[82] U.N. ENV'T PROGRAMME & NAT'L OCEANIC & ATMOSPHERIC ADMIN., THE HONOLULU STRATEGY: A GLOBAL FRAMEWORK FOR PREVENTION AND MANAGEMENT OF MARINE DEBRIS ES-2 tbl.ES-1 (2011), https://wedocs.unep.org/bitstream/handle/20.500.11822/10670/Honolulu%20strategy.pdf?sequence=1&isAllowed=y; U.N. Env't Assembly of the U.N. Env't Programme, *Combating Marine Plastic Litter and Microplastics: An Assessment of the Effectiveness of Relevant International, Regional and Subregional Governance Strategies and Approaches*, U.N. Doc. UNEP/EA.3/INF/5, at 43–44 (2018) [hereinafter UNEP Marine Plastic Litter Assessment]. Earlier international efforts focused more on generic problem definitions applying to all plastic pollutants. KARASIK ET AL., *supra* note 21, at 34.

[83] KARASIK ET AL., *supra* note 21, at 97.

[84] *Id.* at 43.

pollution[85] as a key gap in international policy responses to date.[86] In the absence of a global treaty on plastic pollution, the UNEA has convened states to develop resolutions for collective action. This process has created a framework for collecting information on existing activities and actions by governments, regional and global instruments, international organizations, the private sector, NGOs and other relevant contributors to the problem.[87] Additionally, states have sought to address plastic pollution through the Basel Convention to ensure environmentally sound disposal of hazardous and other wastes.[88] For example, in 2019, the Conference of the Parties (CoP) agreed on stricter controls of transboundary movement of plastic waste and encouraged governments to set time-bound targets to ensure that plastic packaging is designed to be reusable and recyclable and the recycled content in plastic products is increased, among other measures.[89]

At the regional level, the majority of policies have been introduced over the last decade, consisting largely of non-binding action plans facilitated by the United Nations Environment Program (UNEP) in the context of Regional Seas Programs and European Union policies that were often binding but depended upon national legislation (e.g., directives to member states focused on reducing consumption of lightweight plastic carrier bags, or recycling mandates).[90] These policies have often taken a more holistic and comprehensive approach to addressing plastic pollution, focused on leakage across all stages of the life cycle of plastic products, coupled with forward-looking policy actions such as extended producer responsibility requirements, information instruments, or model national legislation.[91] For example, the EU's 2019 policy moved beyond recycling targets to focus on reducing consumption, requiring member states to adopt a mix of instruments that in aggregate were estimated to cover 86% of the single-use plastics found in the states' beach counts, such as bans where plastic

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[85] *Id.*

[86] *See, e.g.*, Carlini & Kleine, *supra* note 7, at 239 (noting that gaps include "the lack of a global institution whose mandate focuses on the coordination of existing efforts, and the management of the marine plastic litter and microplastics across its life cycle . . . . a lack of globally binding standards to mitigate plastic pollution," and an insufficient recognition of "the potential risks to human health . . . [and] the widespread disregard for due diligence and the polluter pays principle by the relevant industry sectors") (footnotes omitted); UNEP Marine Plastic Litter Assessment, *supra* note 82, at 11–12 (identifying "major gaps and challenges in the international, regional and sub-regional frameworks"); Joanna Zofia Vince & Britta Denise Hardesty, *Plastic Pollution Challenges in Marine and Coastal Environments: From Local to Global Governance*, 25 RESTORATION ECOLOGY 123, 124 (2017) ("There is a large gap in international hard law specifically addressing land-based plastic marine pollution.").

[87] U.N. Env't Assembly Res. 4/6, U.N. Doc. UNEP/EA.4/Res.6, at 1–3 (Mar. 15, 2019).

[88] Karen Raubenheimer & Alistair McIlgorm, *Can the Basel and Stockholm Conventions Provide a Global Framework to Reduce the Impact of Marine Plastic Litter?*, 96 MARINE POL'Y 285, 286–89 (2018).

[89] KARASIK ET AL., *supra* note 21, at 42.

[90] *Id.* at 44.

[91] *Id.* at 47.

alternatives were available, coupled with information instruments to help change behavior.[92] However, with the exception of the EU policies, the majority of regional policies, while frequently comprehensive in scope, have rarely been binding.

B. *National and Subnational Policies*

Plastic pollution has frequently been addressed by governments at the sub-national level, particularly in municipalities, often to ban specific items such as plastic carrier bags. In the United States, for example, cities and states have led a regulatory push to ban or tax plastic carrier bags and other pollutants, notably in California.[93] Acting as a laboratory for local plastics regulation in the United States,[94] municipalities throughout the state introduced regulations to combat plastic pollution throughout the last decade, notably including a state-wide ban on the use of plastic carrier bags in 2014.[95] By 2016, 242 local governments had introduced policies aiming to reduce pollution from plastic carrier bags.[96]

Multiple studies have suggested that national policies to address plastic pollution have increased significantly in the last decade, as the issue has risen on the policy agenda.[97] These policies are typically more narrowly focused on specific forms of single-use plastics.[98] In particular, the growth in national policies over the last decade was driven by legislation introduced solely to address pollution from plastic carrier bags, though examples of more comprehensive "all of the above" approaches to macroplastics

[92] Directive 2019/904, of the European Parliament and of the Council of 5 June 2019 on the Reduction of the Impact of Certain Plastic Products on the Environment, 2019 O.J. (L155/1) 7.

[93] Travis P. Wagner, *Reducing Single-Use Plastic Shopping Bags in the USA*, 70 WASTE MGMT. 3, 7 (2017); Jennie R. Romer & Leslie Mintz Tamminen, *Plastic Bag Reduction Ordinances: New York City's Proposed Charge on All Carryout Bags as a Model for U.S. Cities*, 27 TUL. ENV'T L.J. 237, 241, 244, 247 (2014); Jessica R. Coulter, *A Sea of Change to Change the Sea: Stopping the Spread of the Pacific Garbage Patch with Small-Scale Environmental Legislation*, 51 WM. & MARY L. REV. 1959, 1983, 1992 (2010); Rebecca Fromer, Comment, *Concessions of a Shopaholic: An Analysis of the Movement to Minimize Single-Use Shopping Bags from the Waste Stream and a Proposal for State Implementation in Louisiana*, 23 TUL. ENV'T L.J. 493, 502–03, 508 (2010); Jennie Reilly Romer, Comment, *The Evolution of San Francisco's Plastic-Bag Ban*, 1 GOLDEN GATE U. ENV'T L.J. 439, 465 (2007); Clapp & Swanston, *supra* note 72, at 327.

[94] Rebecca L. Taylor & Sofia B. Villas-Boas, *Bans vs. Fees: Disposable Carryout Bag Policies and Bag Usage*, 38 APPLIED ECON. PERSPS. & POL'Y 351, 355–56 (2016).

[95] S. 270, 2013–2014 Leg., Reg. Sess. (Cal. 2014).

[96] Rebecca L.C. Taylor, *Bag Leakage: The Effect of Disposable Carryout Bag Regulations on Unregulated Bags*, 93 J. ENV'T ECON. & MGMT. 254, 255 (2019).

[97] Schnurr et al., *supra* note 72, at 158–60, 159–60 tbl.1, 160 fig.1; UNEP SINGLE-USE PLASTICS REPORT, *supra* note 72, at 10–11; KARASIK ET AL., *supra* note 21, at 57, 58 fig.14.

[98] Schnurr et al., *supra* note 72, at 158–63, 159–60 tbl.1, 161 tbl.2, 164–65 tbl.3.

emerged in recent years.[99] By the first half of 2019, national governments had regulated various forms of plastic carrier bags in at least forty-three countries, most commonly through a ban, and to a lesser extent by tax or levy (but often not paired with information instruments).[100] Countries in Africa have been global leaders in national-level efforts to reduce pollution from plastic carrier bags, particularly through regulatory bans.[101] More broadly, lower- and lower-middle income countries have been more willing to adopt national policies to control plastics pollution.[102]

A regulatory ban is by far the most common instrument implemented at the national level to combat plastics pollution, much more so than economic incentives such as taxes or fees.[103] At least twenty-five countries have banned some form of plastic packaging or other single-use plastic product, beyond plastic carrier bags.[104] Notably, seven of the top twenty producers of mismanaged coastal waste do not have a national policy aiming to address plastic pollution (Philippines, Thailand, Egypt, Algeria, Brazil, Myanmar, and North Korea), and another four only have a policy targeted to plastic carrier bags, based on analysis to date (Nigeria, Bangladesh, South Africa, and Morocco).[105]

National governments have introduced relatively few policies to address microplastic pollution. Of the few national microplastics policies that are in place, all but one was introduced within the last five years.[106] Similarly, only in 2014 did international policies at the global level start to focus on microplastics as part of the plastic pollution problem, with more specificity in UNEA's 2016 resolution (2/11).[107] These policies have typically focused on plastic microbeads in personal care products, leading some researchers to suggest that regulatory bans could feasibly eliminate these microbeads before 2030.[108] Given that the majority of policies introduced by governments to address plastic pollution occurred within the last decade, relatively few observations of their effects on the problem have been published, and these have almost solely focused on laws or regulations for

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[99] KARASIK ET AL., *supra* note 21, at 67 (citing examples of recent comprehensive responses to land-based sources of plastic pollution, including by Denmark and India in 2016 and by Panama, Rwanda, and Tanzania in 2019).

[100] *Id.* at 8–9.

[101] Adam et al., *supra* note 72, at 1.

[102] Clapp & Swanston, *supra* note 72, at 319–20.

[103] KARASIK ET AL., *supra* note 21, at 8–9.

[104] *Id.* at 10.

[105] *Id.* at 62.

[106] *Id.* at 71.

[107] *Id.* at 34, 40–41.

[108] Peter Dauvergne, *Why Is the Global Governance of Plastic Failing the Oceans?*, 51 GLOB. ENV'T CHANGE 22, 25–26 (2018).

plastic bags (largely in Europe and North America).[109] These studies have noted significant effects on reduction in plastic bag consumption, together with unintended consequences in some cases such as increased demand for paper or other non-reusable bags, related to a number of factors including: the amount of the tax or fee set for economic instruments, the availability of inexpensive, reusable alternatives, public awareness and acceptance of the policy, and levels of enforcement of compliance,[110] among others. Beyond studies of policy instruments to address pollution from plastic bags, economic instruments encouraging recycling of plastic beverage containers ("cash deposit schemes") have also been assessed in some cases in Europe and North America.[111] These studies have found strong evidence that such economic instruments reduce pollution from plastic beverage containers, due to increased rates of recycling incentivized by the deposits required.[112]

In summary, while governments' attention to the problem of plastic pollution has grown over the last decade, with more new policies introduced at every level, these have largely been either relatively comprehensive but non-binding at the international level, or more specific and targeted to individual plastic types at the national or sub-national level, most frequently plastic bags. As a result, the current policy landscape is a patchwork, only partially covering many plastic production supply chains.[113] At the same time, though relatively little analysis of effectiveness is yet available beyond some regulation of plastic bags and to a lesser extent plastic beverage containers, governments have clearly preferred regulatory bans to economic instruments among the policy patchwork, and the latter have largely been fees assessed to consumers acting as "nudges," rather than taxes aiming to internalize the social cost of the pollution.[114]

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[109] *See* KARASIK ET AL., *supra* note 21, at 301–08 app. XI (listing publications examining plastics pollution policies).

[110] Patricia K. Mogomotsi, Goemeone E. J. Mogomotsi & Nametso D. Phonchi, *Plastic Bag Usage in a Taxed Environment: Investigation on the Deterrent Nature of Plastic Levy in Maun, Botswana*, 37 WASTE MGMT. & RSCH. 20, 21, 24 (2019); Johane Dikgang, Anthony Leiman & Martine Visser, *Analysis of the Plastic-Bag Levy in South Africa*, 66 RES. CONSERVATION & RECYCLING 59, 60–61 (2012); Taylor & Villas-Boas, *supra* note 94, at 352, 372; Lea Marie Heidbreder et al., *Tackling the Plastic Problem: A Review on Perceptions, Behaviors, and Interventions*, 668 SCI. TOTAL ENV'T 1077, 1079–86 (2019); Graça Martinho, Natacha Balaia & Ana Pires, *The Portuguese Plastic Carrier Bag Tax: The Effects on Consumers' Behavior*, 61 WASTE MGMT. 3, 3–4 (2017); U.N. ENV'T PROGRAMME, SINGLE-USE PLASTICS: A ROADMAP FOR SUSTAINABILITY vii–x (2d ed. 2018) [hereinafter SINGLE-USE PLASTICS SUSTAINABILITY REPORT].

[111] SINGLE-USE PLASTICS SUSTAINABILITY REPORT, *supra* note 110, at 11.

[112] Qamar Schuyler et al., *Economic Incentives Reduce Plastic Inputs to the Ocean*, 96 MARINE POL'Y 250, 250–52, 254 (2018).

[113] WORLD WIDE FUND FOR NATURE, ELLEN MACARTHUR FOUND. & BOS. CONSULTING GRP., THE BUSINESS CASE FOR A UN TREATY ON PLASTIC POLLUTION 23 (2020).

[114] KARASIK ET AL., *supra* note 21, at 82.

C. *The Plastic Pollution-Climate Policy Nexus*

In addition to policies aimed directly at reducing plastics pollution, there are also two important connections between climate change policies and plastics. Like many industrial sectors, each step of the plastics manufacturing process produces GHG emissions and other harmful pollutants, from producing and transporting raw materials, manufacturing plastics, and transporting the products to their respective markets.[115] Unlike many other sectors, however, plastics manufacturing also depends upon petroleum or natural gas as a feedstock.[116]

Plastics, along with fertilizers and other products that depend upon petrochemical feedstocks, account for approximately 12% of global oil demand, thus amplifying the sector's GHG emissions impact.[117] The Organization of the Petroleum Exporting Countries (OPEC) projects that the petrochemical sector will be "the largest single contributor to incremental oil demand" through 2045.[118] According to a 2016 report by the Ellen MacArthur Foundation, plastic production could quadruple by 2050, accounting for "20% of total oil consumption and 15% of the global annual carbon budget by 2050."[119]

Policies aimed at reducing GHG emissions necessarily impact fossil fuel consumption, at least in the absence of cost-effective, technologically feasible carbon capture technologies. Plastics manufacturing is not an exception. Nonetheless, a carbon price would have less of an impact on plastics manufacturing than on other sectors of the economy where the climate change impact is due to direct emissions from a smokestack or tailpipe rather than the emissions embedded in a feedstock. The cost of refining petroleum would increase, but not necessarily enough to impact the competitiveness of alternatives to virgin plastics.

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[115] *See, e.g.*, Jiajia Zheng & Sangwon Suh, *Strategies to Reduce the Global Carbon Footprint of Plastics*, 9 NATURE CLIMATE CHANGE 374, 374 (2019) (projecting that "GHG emissions from plastics would reach 15% of the global carbon budget by 2050" if current production trends continue); LISA ANNE HAMILTON ET AL., PLASTIC & CLIMATE: THE HIDDEN COSTS OF A PLASTIC PLANET 80 (Amanda Kistler & Carroll Muffett eds., 2019) (projecting that the lifecycle emissions from plastics could reach 1.34 gigatons per year by 2030).

[116] Plastics manufacturing depends upon either petroleum or natural gas products. HAMILTON ET AL., *supra* note 115, at 21.

[117] INT'L ENERGY AGENCY, THE FUTURE OF PETROCHEMICALS: TOWARDS MORE SUSTAINABLE PLASTICS AND FERTILISERS 78 (2018).

[118] ORG. OF THE PETROLEUM EXPORTING COUNTRIES, 2020 WORLD OIL OUTLOOK 2045 114 (2020). The OPEC projections show oil demand by the petrochemical sector increasing by 3.7 million barrels of oil per day. *Id.* at 91 ("The petrochemicals sector (+3.7 mb/d), followed by aviation (+2.8 mb/d) and road transportation (+2.6 mb/d), will be the primary drivers of oil demand between 2019 and 2045."). Similarly, the 2019 BP Energy Outlook found that "the noncombusted use of fuels within industry—particularly as a feedstock in petrochemicals—is the fastest growing source of incremental [energy] demand." BP, BP ENERGY OUTLOOK 29 (2019 ed., 2019).

[119] WORLD ECON. F., ELLEN MACARTHUR FOUND. & MCKINSEY & CO., THE NEW PLASTICS ECONOMY: RETHINKING THE FUTURE OF PLASTICS 17, 24 (2016).

Carbon markets, such as the European Emissions Trading Scheme or the California Cap-and-Trade Program, focus on smokestack emissions.[120] There are several reasons why policymakers make this choice, primary among them are administrative efficiency and monitoring.[121] There is a discrete number of facilities emitting more than 25,000 tons of CO_2e per year and it is relatively straightforward to measure emissions from these facilities.[122] Carbon markets typically do not focus on emissions that may occur upstream from those facilities.[123] Instead, these policies rely on the increase in production costs to reduce demand for products with higher associated emissions.[124] This means that the petroleum refining stage would be subject to the emissions cap rather than the extraction, distribution, or end-use stages.

Nonetheless, a carbon price may impact the economics of plastics production, particularly if the price gap narrows between virgin plastics and recycled plastics or alternative products. In turn, the expanded market for recycled plastics or packaging alternatives could reduce demand for virgin plastic as carbon price increase. Carbon market revenue can also support technology innovation, such as California's Greenhouse Gas Reduction Fund that deploys auction proceeds from the state's Cap-and-Trade Program to "increase[] in-state diversion of municipal solid waste from disposal through waste reduction, diversion, and reuse."[125]

Perhaps counterintuitively, a price on GHG emissions could also have the opposite effect by incentivizing investment in virgin plastics if demand for petroleum as a transportation fuel is projected to decline in the coming decades due to electrification and efficiency improvements.[126] Petroleum companies lose market share in a carbon constrained future when consumers shift to lower emitting vehicles or electric vehicles. Climate policies may similarly reduce demand for natural gas. The emphasis on plastics may increase if petroleum and natural gas companies look for new revenue

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[120] Alice Kaswan, *Decentralizing Cap-and-Trade? State Controls Within a Federal Greenhouse Gas Cap-and-Trade Program*, 28 VA. ENV'T L.J. 343, 358 (2010).

[121] *Id.* at 351.

[122] *Key Facts and Figures*, U.S. ENV'T PROT. AGENCY: GREENHOUSE GAS REPORTING PROGRAM (GHGRP), https://www.epa.gov/ghgreporting/key-facts-and-figures (Nov. 9, 2020).

[123] Eliot Metzger, *Bottom Line on Cap-and-Trade*, WORLD RES. INST., June 2008, at 1, 1, https://www.wri.org/research/bottom-line-cap-and-trade.

[124] *Id.*

[125] *Greenhouse Gas Reduction Grant and Loan Programs*, CALRECYCLE, https://www.calrecycle.ca.gov/Climate/GrantsLoans/ (May 28, 2021). These grants "are targeted to build or expand organics infrastructure, such as composting and anaerobic digestion, or rescuing food to feed hungry people, as well as new or expanded infrastructure for manufacturing products with recycled content fiber, plastic, or glass." *Id.*

[126] Amy Harder, *Oil Companies Double Down on Plastics as Public Outcry Grows*, AXIOS (June 17, 2019), https://www.axios.com/oil-companies-double-down-on-plastics-as-public-outcry-grows-1dcb68ce-5559-47e3-8745-a192a0a106e7.html.

streams to replace demand from the transportation and electricity sectors.[127] There is some evidence that this is already underway.[128]

III. TOWARD A BROADER MARKET-BASED APPROACH TO PLASTICS POLLUTION

Each of the existing approaches to plastics pollution have limitations. The current scope of local plastics bans may help limit local pollution but will not likely affect global plastics production or incentivize innovation, given their inconsistent application to markets through a patchwork of national and municipal laws and regulations around the world.[129] Similarly, current pricing instruments function as policy nudges that seek to influence consumer choices.[130] Nudges can address some of the behavioral aspects of the pollution problem, but these limited pricing policies cannot address the exponential growth of plastics production.[131] Depending on the policy design, climate policy alone may reduce plastics production, or may create incentives for increased investment in plastics production to counter reduced demand for transportation fuels. Broader responses are therefore necessary to halt the trajectory of plastics growth through development of alternative products and improved waste management.

There is increasing interest in pollution pricing and pollution caps to address plastics to help states meet any binding targets to reduce plastic pollution, particularly to target single-use plastics or non-recycled plastics.[132] For example, the European Council approved a tax on non-recycled plastic packaging as part of the July 2020 Covid recovery plan and the EU agreed on a tax for plastic packaging waste for member states to introduce.[133] Broader use of market-based policies can address many of the

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[127] *See, e.g.*, Hiroko Tabuchi, Michael Corkery & Carlos Mureithi, *Big Oil Is in Trouble. Its Plan: Flood Africa with Plastic.*, N.Y. TIMES (Aug. 30, 2020), https://www.nytimes.com/2020/08/30/climate/oil-kenya-africa-plastics-trade.html (reporting on efforts to increase plastics production in Africa and overturn anti-plastics policies).

[128] *See, e.g.*, *id.* (reporting on efforts to reverse Kenya's limits on domestic plastics and imported waste).

[129] KARASIK ET AL., *supra* note 21, at 82.

[130] *Id.*

[131] *Id.* A tax on plastic bags, for example, can encourage shoppers to bring their own bags or place more products in a bag.

[132] *See, e.g.*, *Taxes on Single-Use Plastics*, OECD, https://www.oecd.org/stories/ocean/taxes-on-single-use-plastics-186a058b (last visited Sep. 22, 2021) ("Taxes on plastic material, certain types of plastics polymer or certain uses of plastics (e.g.[,] single-use packaging) can help reduce unsustainable consumption of plastic materials."); Chantal Carriere & Rachael Beavers Horne, *The Case for a Legislated Market in Minimum Recycled Content for Plastics*, 50 ENV'T L. REP. 10042, 10050 (2020) (proposing a market-based approach for mandating minimum recycled content for single-use plastic packaging).

[133] General Secretariat of the Council Conclusions, Special Meeting of the European Council (17, 18, 19, 20 and 21 July 2020), Brussels European Council, ¶¶ A29, 146 (July 21, 2020), https://www.consilium.europa.eu/media/45109/210720-euco-final-conclusions-en.pdf.

economic, technical, and behavioral challenges identified in Part I of this Article, depending upon the context.

A century ago, Arthur Pigou recognized that pollution and other negative externalities occur when those who produce the pollution avoid paying for the societal harm they cause.[134] Imposing a fee can change the economic calculation. Higher polluting options that were economic in the absence of an emissions price may become less competitive if the production process incorporates the cost that pollution imposes on society.[135] Firms facing a price on pollution can choose to either pay the price or reduce or eliminate the targeted pollution.[136] The flexibility allowed by market-based approaches can reduce compliance costs and, if the price or pollution cap is set at an appropriate level, overall pollution will decrease.[137]

A pollution tax or auctioned allowances can generate revenue that can fund waste management programs or technology research and development.[138] In addition, the price itself may induce investment in new waste management and recycling options, or development of new products with less environmental harm.[139] Higher prices for plastic products or expanded use of fees or taxes for consumer goods with non-recycled plastic packaging can change behavioral incentives, and increased availability of consumer options can facilitate different choices.[140]

Plastics pollution shares important characteristics with climate change, and these similarities allow climate policy to inform design of market-based plastics pollution policies.[141] As a starting point, both GHGs and plastics can be characterized as stock pollutants that cause harm due to their accumulation in the environment, as opposed flow pollutants that may have cumulative

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[134] ARTHUR CECIL PIGOU, THE ECONOMICS OF WELFARE 27–28 (1920).

[135] *See, e.g.*, NATHANIEL O. KEOHANE & SHEILA M. OLMSTEAD, MARKETS AND THE ENVIRONMENT 180 (2d ed. 2016) (comparing policy instruments and finding "the incentive to adopt new technologies with lower marginal costs is greater under an emission tax [and cap-and-trade system] than under a performance standard").

[136] Ted Gayer, *Pricing Pollution*, BROOKINGS (Jan. 5, 2011), https://www.brookings.edu/articles/pricing-pollution/.

[137] OFF. OF MGMT. & BUDGET, EXEC. OFF. OF THE PRESIDENT, A NEW ERA OF RESPONSIBILITY: RENEWING AMERICA'S PROMISE 100 (2009) (noting that the Acid Rain Trading Program "dramatically reduced acid rain at much lower costs than the traditional Government regulations and mandates of the past").

[138] MARISSA SANTIKARN ET AL., THE USE OF AUCTION REVENUE FROM EMISSIONS TRADING SYSTEMS: DELIVERING ENVIRONMENTAL, ECONOMIC, AND SOCIAL BENEFITS 6, 10, 12 (2019).

[139] *See Taxes on Single-Use Plastics*, OECD, *supra* note 132 ("The application of taxes to single-use plastic items can help to increase the price of such items, and therefore drive demand away from such items and result in substitution. Well-designed taxes should lead to the use of more durable and/or more sustainable alternatives.").

[140] *See id.* (summarizing the impacts of various taxes on single-use plastics around the world).

[141] *Economic Incentives*, U.S. ENV'T PROT. AGENCY: ENV'T ECON., https://www.epa.gov/environmental-economics/economic-incentives (last visited Sept. 22, 2021).

health effects but do not accumulate in the environment.[142] GHGs accumulate in the atmosphere and plastic pollutants accumulate in freshwater and ocean ecosystems.[143] This distinction between stock and flow pollutants can help inform policy design by, for example, affecting the slope of the economic benefits curve of reductions as a factor in choice of instruments.[144]

Technologies exist to reduce GHG emissions and alternatives exist for many uses of plastics, but these alternatives compete with existing supply chains that create economic and political barriers to options with less social and environmental impacts. The alternatives to high GHG emissions or plastics may also be more expensive, particularly if the sources of pollution can externalize the social and environmental harms.

Similar to plastics pollution, the geography of GHG emissions varies widely, by country and by economic sector.[145] The businesses and nations that are the largest sources of GHG emissions are not necessarily the same areas that are experiencing the most severe near-term impacts of climate change.[146] Disparities between those contributing to the global challenge and those that are harmed result in economic incentives at the national and firm level to continue creating the pollution.[147] A handful of countries are responsible for the vast majority of anthropogenic GHG emissions, but population growth and economic development in developing countries are causing a shift in the major emitters.[148]

A common refrain among opponents of U.S. climate policy is that the country could cut emissions completely, but it would not have an impact because emissions in other parts of the world are likely to climb.[149] There are obvious responses. The United States was the largest emitter historically, and thus is largely responsible for much of the current atmospheric

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[142] Diego Villarreal, *Understanding GHG Emissions: Stock vs. Flows*, COLUM. CLIMATE SCH.: STATE OF THE PLANET (July 18, 2011), https://news.climate.columbia.edu/2011/07/18/understanding-ghg-emissions-stock-vs-flows/.

[143] Penghui Li et al., *Characteristics of Plastic Pollution in the Environment: A Review*, 107 BULL. ENV'T CONTAMINATION & TOXICOLOGY 577, 577–78 (2020).

[144] Villarreal, *supra* note 142.

[145] *Projected Growth in CO2 Emissions Driven by Countries Outside the OECD*, U.S. ENERGY INFO. ADMIN. (May 16, 2016), https://www.eia.gov/todayinenergy/detail.php?id=26252.

[146] Glenn Althor, James E. M. Watson & Richard A. Fuller, *Global Mismatch Between Greenhouse Gas Emissions and the Burden of Climate Change*, 6 SCI. REPS., Feb. 5, 2016, at 1, 1–3, https://www.nature.com/articles/srep20281.pdf.

[147] *Id.*

[148] *Economic Incentives*, *supra* note 141.

[149] *See, e.g.*, Charli Coon, *Why President Bush Is Right to Abandon the Kyoto Protocol*, HERITAGE FOUND. (May 11, 2001), https://www.heritage.org/node/19307/print-display ("[A]ny agreement that allows the developing countries to continue emitting greenhouse gases would in effect negate the efforts of those countries that are trying to reduce them. It would drastically increase the cost of gasoline, electricity, and fuel oil for Americans and cause significant harm to the U.S. economy.").

concentration.[150] The United States remains the second largest global emitter, behind China, despite the rise in emissions from developing countries.[151] The argument for U.S. inaction also rings hollow because other countries can use the same critique to avoid action.[152] A similar dynamic could impact global efforts to reduce plastics pollution if the United States—currently the largest producer of plastic waste—refuses to support international negotiations.[153]

Just as there are numerous similarities in the characteristics of the plastic pollution and climate change problems, there are important differences that can allow more flexibility in plastics policy. Climate change is causing different regional climate and weather impacts, but GHG emissions are globally mixing pollutants. Emissions from anywhere in the world have the same impact on global atmospheric concentration, and thus heat-trapping, no matter where emissions occur.[154] Therefore, actions to reduce emissions in some regions may not result in an overall decrease in atmospheric concentration if emissions increase in other regions.

With plastics, the problem is primarily the product rather than the manufacturing process. There are social and environmental impacts throughout the plastics value chain, but the harms that distinguish plastics from other materials is the plastic itself. With climate change, the harmful pollutants are externalities resulting from the production of the desired products or services. This means that it is possible to reduce the plastic pollution by replacing the products with less harmful alternatives. The other social and environmental problems associated with plastic production may also arise with the alternatives, such as pollution from extraction of raw materials, manufacturing, and transportation, and impacts of waste on communities, but plastic pollution would decrease. Additionally, not all plastic products contribute equally to local, national, or international plastics pollution. Single-use food packaging, for example, is a larger contributor to

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[150] Chris Mooney, *The U.S. Has Caused More Global Warming than Any Other Country. Here's How the Earth Will Get Its Revenge.*, WASH. POST (Jan. 22, 2015), https://www.washingtonpost.com/news/energy-environment/wp/2015/01/22/the-u-s-has-contributed-more-to-global-warming-than-any-other-country-heres-how-the-earth-will-get-its-revenge/.

[151] *Global Greenhouse Gas Emissions Data*, U.S. ENV'T PROT. AGENCY: GREENHOUSE GAS EMISSIONS, https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data (Oct. 26, 2021).

[152] *See, e.g.*, Muyu Xu & David Stanway, *China Accuses U.S. of Deflecting Blame as Diplomatic Row Shifts to Climate*, REUTERS, https://www.reuters.com/article/us-climatechange-china-politics/china-accuses-u-s-of-deflecting-blame-as-diplomatic-row-shifts-to-climate-idUSKBN27D0JB (Oct. 28, 2020, 1:51 AM) (discussing Chinese criticisms of U.S. inaction on climate change).

[153] *See* Lavender Law et al., *supra* note 57, at 3 (finding that the United States is responsible for the largest amount of global plastic waste as compared to other countries responsible for producing plastic itself).

[154] *See* KEVIN A. BAUMERT, TIMOTHY HERZOG & JONATHAN PERSHING, NAVIGATING THE NUMBERS: GREENHOUSE GAS DATA AND INTERNATIONAL CLIMATE POLICY 16 (2005) (discussing how the lack of international cooperation will fail to mitigate GHG emissions). *See also What Is a Carbon Offset?*, CARBON OFFSET GUIDE, http://www.offsetguide.org/understanding-carbon-offsets/what-is-a-carbon-offset/ (last visited Sept. 19, 2021) (explaining the impact of GHGs mixing globally).

the plastic waste problem than plastics used for construction.[155] Some types of plastics may offer benefits that outweigh the harms of pollution (e.g., medical supplies and protective equipment compared with single-use plastic bottles).[156]

Additionally, while ocean plastic pollution is a global problem, plastic pollution can have local, regional, and global impacts depending on how the waste is managed.[157] This changes the self-interest calculus and the ability for unilateral action to result in tangible benefits. It also points to the need for additional complementary policies to provide a comprehensive response to the different scales of the plastics pollution challenge.

This Part begins with an overview of the key design choices that policymakers must consider when designing a new market-based pollution abatement program. The discussion then turns to the climate policy lessons that can inform market-based plastics pollution policy design. Part III.B provides a brief history of climate policy to explain how policy design choices are reflected in major national and international climate policies. These existing policy choices provide a foundation for the subsequent focus on lessons for plastics policy. The Part concludes with seven specific lessons from climate policy than can inform new market-based plastics pollution policies, including areas where the differences between plastics pollution and climate change may suggest a particular approach for plastics.

A. *Design Choices for Market-Based Pollution Abatement Policies*

A starting point for pricing plastics pollution, or any form of pollution for that matter, is identifying the pollutants, products, processes, or attributes that are subject to the price. The design of a market-based approach creates incentives for certain types of behavior. What is allowed by the market rules, and what is left out, will determine which environmental and social goals are addressed.

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[155] SINGLE-USE PLASTICS SUSTAINABILITY REPORT, *supra* note 110, at 4 fig.1.2 (illustrating how single-use plastics production in the packaging industry exceeds plastic production in the building and construction industry).

[156] *See, e.g.*, Neha Parashar & Subrata Hait, *Plastics in the Time of COVID-19 Pandemic: Protector or Polluter?*, 759 SCI. TOTAL ENV'T, Dec. 20, 2020, at 1, 2, https://doi.org/10.1016/j.scitotenv.2020.144274 ("Plastics have contributed immensely to the healthcare sector and public health safety during the pandemic. In addition to the imposition of nationwide lockdown, social distancing, restriction on traveling and public gathering, frequent usage of hand sanitizers along with wearing of mostly plastic-based personal protective equipment (PPEs), viz. face masks, gloves for common citizens to protective medical suits, aprons, gowns, face shields, surgical masks, and other PPEs for frontline health workers as precautionary measures have been adopted to avoid virus contamination to fight the spread of COVID-19.")

[157] *See, e.g.*, *Study of the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs on the Environmental Impacts of Plastics and Micro-Plastics Use, Waste and Pollution: EU and National Measures*, at 36 (Oct. 22, 2020), https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658279/IPOL_STU(2020)658279_EN.pdf (concluding that "[r]egional initiatives are also insufficient to address the issue of pollution, as local or regional (eco)systems are interconnected to wider and larger networks such as ocean currents and migratory pathways").

Policymakers designing a market-based approach to plastics pollution must decide what unit to measure—e.g., volume, type of plastic, pre-consumer or post-consumer content, recyclability, emissions associated with production, or use of the plastic product. Similarly, policymakers face a threshold question of how to set a pollution price or cap.

A market-based pollution abatement policy can implement the pollution price via a pollution tax or set a quantitative limit on pollution, commonly referred to as a "cap-and-trade" program.[158] A pollution tax requires emitters to pay the specified price for each unit of pollution released during a compliance period. A cap-and-trade program is more complex but can create more compliance flexibility that results in a lower cost. Policymakers may use economic models to translate the pollution price into a quantitative limit or set the limit without starting with cost. The policy specifies the pollution cap for a compliance period (e.g., one year) and issues one allowance (or tradeable credit) for each unit of pollution allowed under the cap.[159] For example, if a hypothetical cap-and-trade program caps pollution at 100 tons of pollution emitted annually, there would be 100 allowances available each year.[160] Parties may trade the allowances and those subject to the pollution cap must have permits for each unit of pollution (e.g., tons of carbon dioxide) emitted during a compliance period.[161] The allowance price is determined by supply and demand of available allowances.[162]

The compliance flexibility of a tax or a market allows individual entities to decide whether to reduce emissions at their facilities or pay a price for the emissions.[163] These approaches result in different types of uncertainty.[164] The pollution tax creates cost certainty but may or may not achieve the

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[158] Policies with quantitative limits do not have to allow trading. Policies can set firm pollution limits for each source.

[159] *See How Do Emissions Trading Programs Work?*, U.S. ENV'T PROT. AGENCY: EMISSIONS TRADING RES., https://www.epa.gov/emissions-trading-resources/how-do-emissions-trading-programs-work (July 8, 2021) (summarizing the key elements of an emissions trading program).

[160] These policies can distribute the allowances for free, sell the allowances via auction, or do a combination of the two. *See, e.g.*, *Allowance Allocation: Overview*, CAL. AIR RES. BD., https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation (last visited Sept. 19, 2021) ("CARB distributes allowances to the Cap-and-Trade Program market through two primary mechanisms: direct allocation to regulated entities and sale at auction to all market participants.").

[161] *How Do Emissions Trading Programs Work?*, *supra* note 159.

[162] Bruce R. Huber, *How Did RGGI Do It? Political Economy and Emissions Auctions*, 40 ECOLOGY L.Q. 59, 77–78 (2013).

[163] *See* Hannah J. Wiseman & Hari M. Osofsky, *Regional Energy Governance and U.S. Carbon Emissions*, 43 ECOLOGY L.Q. 143, 163–64 (2016) (describing a hypothetical trading system).

[164] *See* Lawrence H. Goulder & Andrew R. Schein, *Carbon Taxes Versus Cap and Trade: A Critical Review*, 4 CLIMATE CHANGE ECON. 1350010-1, 1350010-1–3 (2013) (comparing a carbon tax, a cap-and-trade system, and a hybrid approach); Wiener, *supra* note 14, at 515–18 (describing different types of emissions pricing policy instruments).

desired pollution reduction.[165] The quantitative approach creates certainty about the amount of pollution, but relying on market dynamics to determine the price creates uncertainty regarding the cost of allowances.[166] Allowance prices may fluctuate depending on factors such as policy stringency, policy timeline, disruptions in supply chains, shifting projections about product demand, or the state of the overall economy.[167]

Policymakers from multiple jurisdictions can work together to design a single set of rules governing the market-based approach or, alternatively, can design the policy to apply solely to their respective jurisdictions. Policy linkage allows market-based approaches implemented by different governments to collectively send a broader price signal and potentially increase compliance flexibility. However, relying on linkage to expand existing pollution abatement markets may require policy adjustments by the linking jurisdictions. Depending on the degree of commitment each jurisdiction has to its existing market design choices, the need for adjustments may create barriers to successful linkage. For example, differences regarding the pollution limit, the market participants, the compliance obligations, whether a jurisdiction auctions or freely allocates allowances, and the availability of cost containment provisions may prohibit market interaction.

B. *A Brief History of U.S. and International Carbon Pricing*

Leading up to 2010, climate policy debates in the United States and internationally focused on developing uniform, legally enforceable requirements to reduce GHG emissions. Emissions markets were a central feature in domestic and international policy design.[168]

The 1992 United Nations Conference on Environment and Development launched the United Nations Framework Convention on Climate Change (UNFCCC), which remains the primary forum for international climate negotiations.[169] From the beginning, negotiators sought binding acceptance of the concept of "common but differentiated responsibilities," creating

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[165] KEOHANE & OLMSTEAD, *supra* note 135, at 144–45.

[166] *Id.*

[167] Harrison Fell & Richard D. Morgenstern, *Collaring Price Volatility in a Carbon Offset Market*, RES. (Mar. 15, 2010), https://www.resourcesmag.org/common-resources/collaring-price-volatility-in-a-carbon-offset-market/ ("Price volatility arises because in a traditional cap-and-trade program, annual emissions levels are fixed, but other price determining factors can vary from year to year.").

[168] *Emissions Trading*, U.N. CLIMATE CHANGE, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading (last visited Oct. 8, 2021).

[169] United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107 [hereinafter U.N. Framework Convention]; *Status of Ratification of the Convention*, U.N. CLIMATE CHANGE, https://unfccc.int/process-and-meetings/the-convention/status-of-ratification/status-of-ratification-of-the-convention (last visited Nov. 20, 2021).

different obligations for developed and developing countries.[170] The UNFCCC called for developed countries to adopt binding commitments to reduce GHG emissions.[171] The UNFCCC also called for developed countries to provide financial resources to help developing countries reduce emissions and adapt to climate change.[172] The 2007 Kyoto Protocol formally adopted the "common but differentiated responsibilities" framework, establishing emission reduction targets for developed countries and no commitments for developing countries.[173] The Kyoto Protocol implemented climate mitigation architecture for the initial period of 2008 through 2012, with the U.N. serving as the central body for monitoring compliance.[174]

The Kyoto Protocol authorized emissions trading and created the first compliance-based international carbon offsets markets.[175] One offsets market, the Clean Development Mechanism (CDM), allowed developed countries to fund emission abatement projects in developing countries and receive credits representing the equivalent of one metric ton of CO_2 each.[176] Another program, Joint Implementation (JI), created a separate commodity—emission reduction units (ERUs)—to facilitate cooperation on abatement projects among developed countries.[177]

The Kyoto Protocol was controversial from the beginning. The U.S. Senate passed a non-binding resolution opposing U.S. participation in the Protocol by a vote of 95-0 against ratification, due in part to the failure to impose emission reduction targets on all nations.[178] In 2001, then-President George W. Bush announced his opposition to the Protocol, effectively

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[170] U.N. Framework Convention, *supra* note 169, art. 4.1.

[171] *Id.* art. 4.2(a).

[172] *Id.* art. 4.3, 4.5, 4.8.

[173] Kyoto Protocol to the United Nations Framework Convention on Climate Change art. 10, Dec. 10, 1997, 2303 U.N.T.S. 148.

[174] *Id.* art. 3.1.

[175] *Id.* arts. 6, 12, 16 bis.

[176] U.N. Conference of the Parties on Its Seventh Session, *Modalities and Procedures for a Clean Development Mechanism, as Defined in Article 12 of the Kyoto Protocol*, U.N. Doc. FCCC/CP/2001/13/Add.2, at 20–50 (Jan. 21, 2002).

[177] *Joint Implementation*, U.N. CLIMATE CHANGE, http://unfccc.int/kyoto_protocol/mechanisms/joint_implementation/items/1674.php (last visited Oct. 6, 2021).

[178] S. Res. 98, 105th Cong. (1997). The resolution stated:

> The United States should not be a signatory to any protocol to, or other agreement regarding, the United Nations Framework Convention on Climate Change of 1992, at negotiations in Kyoto in December 1997, or thereafter, which would . . . mandate new commitments to limit or reduce greenhouse gas emissions for the Annex I Parties, unless the protocol or other agreement also mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period, or . . . would result in serious harm to the economy of the United States.

Id.

ending any prospect of U.S. participation.[179] Some developed countries became parties to the agreement, but failed to meet their commitments.[180] One of these countries, Canada, withdrew from the Protocol.[181] The CDM lacked sufficient oversight and verification, resulting in ineffective projects and, in some instances, fraud.[182] Recognizing these limitations, international negotiators focused on creating a new agreement to replace the Kyoto Protocol even as member countries to the Protocol were engaged in separate negotiations to extend the existing framework.[183]

The UNFCCC negotiations originally focused on developing a uniform, legally binding agreement that specified commitments for all member countries, with the goal of completing an agreement in 2009.[184] Achieving unanimous approval of the common framework proved too difficult, and the near failure of the 2009 negotiations in Copenhagen forced member countries to abandon the top-down approach.[185] Instead, the process resulted in the 2015 Paris Agreement that established a decentralized process that identified a common emissions reduction goal, but relied on each country to specify unilateral emission reduction targets and implement the policies to achieve the targets.[186] Article 6 of the Agreement authorizes multilateral market-based mitigation strategies.[187] These approaches could include linking separate carbon pricing mechanisms or offset credits.[188] Article 6 also authorizes emissions pricing, such as carbon taxes, as an alternative to emission trading systems.[189] This new strategy allowed member countries to build upon

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[179] Letter to Members of the Senate on the Kyoto Protocol on Climate Change, 2001, 37 WEEKLY COMP. PRES. DOC. 431, 444 (Mar. 13, 2001).

[180] Isabeau Doucet, *Canada, the Surprise 'Pariah' of the Kyoto Protocol*, GUARDIAN (Nov. 26, 2012, 1:43 PM), https://www.theguardian.com/world/2012/nov/26/canada-kyoto.

[181] *Canada Pulls Out of Kyoto Protocol*, CBC, https://www.cbc.ca/news/politics/canada-pulls-out-of-kyoto-protocol-1.999072 (Dec. 13, 2011).

[182] *See, e.g.*, Michael Wara, *Measuring the Clean Development Mechanism's Performance and Potential*, 55 UCLA L. REV. 1759, 1783–87 (2008) (describing how the CDM created incentives to manufacture hydroflourocarbon—a potent greenhouse gas).

[183] *See* David A. Wirth, *The International and Domestic Law of Climate Change: A Binding International Agreement Without the Senate or Congress?*, 39 HARV. ENV'T L. REV. 515, 524 (2015) (describing the parallel UNFCCC efforts to develop a new international agreement by 2009 and to negotiate an extension of the Kyoto Protocol).

[184] Monast, *supra* note 10, at 183.

[185] *Id.* at 202–05.

[186] *See generally* Environment and Conservation: Climate Change Agreement Between the United States of America and Other Governments, Dec. 12, 2015, T.I.A.S. No. 16-1104 [hereinafter Paris Agreement].

[187] *Id.* art. 6.2 (recognizing that some parties may use "internationally transferred mitigation outcomes" to comply with nationally determined commitments).

[188] *Id.* arts. 6.2, 6.4.

[189] *Id.* art. 6.8; Kelley Kizzier, Kelly Levin & Mandy Rambharos, *What You Need to Know About Article 6 of the Paris Agreement*, WORLD RES. INST. (Dec. 2, 2019), https://www.wri.org/insights/what-you-need-know-about-article-6-paris-agreement ("Article 6.8 establishes a work program for non-market approaches, such as applying taxes to discourage emissions.").

established carbon markets, such as the EU Emission Trading Scheme, and carbon taxes that were already in place or under development.[190]

Climate policy efforts in the United States followed a similar trajectory from a single, top-down approach established by federal statute to a decentralized approach established through state laws and the existing Clean Air Act.[191] The first major U.S. climate bills, introduced in Congress between 2003 and 2007, proposed national carbon markets covering most sectors of the economy.[192] Building upon these early bills, the American Clean Energy and Security Act (commonly known as the Waxman-Markey bill) passed the U.S. House of Representatives in 2009.[193] The legislation included a GHG cap-and trade system, including an emissions cap that declined on a specified schedule between 2012 and 2050, specific rules for allowance allocation and auctioning, mechanisms to protect energy-intensive industries whose competitiveness could be jeopardized by higher energy prices resulting from the carbon price, offsets provisions, and a market oversight regime.[194] The companion bill stalled in the U.S. Senate in 2010,[195] effectively halting congressional efforts to implement new federal legislation to mitigate climate change.

Similar to the international negotiations, the focus of climate policy in the United States shifted away from a single, top-down federal climate bill that would apply a common set of rules and obligations to most sectors of the economy.[196] Instead, the focus turned to state policies and the environmental federalism framework of the Clean Air Act. States implemented two carbon markets in the United States between 2009 and 2012—the California Cap-and-Trade Program that includes international linkage to Canadian provincial carbon policies and the Regional Greenhouse Gas Initiative (RGGI) that includes ten Northeast and Mid-Atlantic states with two additional states in the process of joining the market.[197] The Obama administration sought to build upon these efforts with the promulgation of the Clean Power Plan, a Clean Air Act rule targeting GHG emissions from

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[190] WORLD BANK GRP., STATE AND TRENDS OF CARBON PRICING 2018 24–31 (2018) (summarizing recent developments and emerging trends in carbon pricing policies across the globe).

[191] Monast, *supra* note 10, at 179–205 (describing the UNFCCC process and U.S. climate policy developments through 2017).

[192] For examples of early U.S. climate bills, see America's Climate Security Act of 2007, S. 2191, 110th Cong. (2007); Electric Utility Cap and Trade Act of 2007, S. 317, 110th Cong. (2007); Safe Climate Act of 2007, H.R. 1590, 110th Cong. (2007); Climate Stewardship Act of 2003, S. 139, 108th Cong. (2003); Climate Stewardship and Innovation Act of 2005, S. 1151, 109th Cong. (2005).

[193] American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).

[194] *Id.*

[195] Carl Hulse & David M. Herszenhorn, *Democrats Call Off Effort for Climate Bill in Senate*, N.Y. TIMES, July 22, 2010, at A15.

[196] Monast, *supra* note 10, at 176–79.

[197] *Welcome*, REG'L GREENHOUSE GAS INITIATIVE, www.rggi.org (last visited Nov. 21, 2021); VA. CODE ANN. § 10.1-1330(B) (2021); Pa. Exec. Order No. 2019-07 As Amended (June 22, 2020), https://www.oa.pa.gov/Policies/eo/Documents/2019-07.pdf (directing the state's environmental agency to begin a rulemaking process in order for Pennsylvania to participate in RGGI).

existing power plants.[198] That rule established emission targets for each state, based on their respective electricity generation mix, and allowed states to meet the targets using emissions trading.[199] The U.S. Supreme Court stayed the rule before states could begin implementation, and the Trump administration subsequently replaced the rule with one that did not allow emissions trading.[200]

C. *Climate Policy Lessons for a Market-Based Plastics Pollution Policy*

This Subpart builds upon these similarities and differences between plastics pollution and GHG emissions, identifying lessons from domestic and international climate policy developments that can inform the design of plastics pollution policy, using the case of plastic packaging. The Subpart identifies seven lessons from climate policy design that can help frame policy options to address pollution from plastic packaging: defining the unit of measurement, setting the price or pollution limit, choosing between price certainty or quantity certainty, assigning compliance obligations, avoiding pollution leakage, choosing between top-down or bottom-up frameworks, and facilitating international policy linkage.

1. *Defining the Unit of Measurement*

Some environmental markets are relatively straightforward. For example, the Acid Rain Program, established by the 1990 Clean Air Act amendments, focuses on a single pollutant (sulfur dioxide or SO_2), a single category of sources (coal-fired power plants), and a particular geographic area (eastern United States).[201] The program established a cap on emissions to avoid the environmental harm of acid rain—a problem that allows a regional, as opposed to a source-specific, approach.[202] Any coal-fired power plant subject to the cap must have allowances, representing one ton of SO_2, for each ton emitted during the compliance period.[203] The allowances are fungible—there is a common unit of measurement (tons of SO_2) and the

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[198] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,661 (Oct. 23, 2015) (to be codified at 40 C.F.R. pt. 60).

[199] Federal Plan Requirements for Greenhouse Gas Emissions from Electric Utility Generating Units Constructed on or Before January 8, 2014; Model Trading Rules; Amendments to Framework Regulations, 80 Fed. Reg. 65,015–16 (Oct. 23, 2015) (to be codified at 40 C.F.R. pts. 60, 62, 78).

[200] West Virginia v. EPA, 577 U.S. 1126, 1126 (2016) (granting stay); Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations, 84 Fed. Reg. 32,520 (July 8, 2019) (to be codified at 40 C.F.R. pt. 60).

[201] *Acid Rain Program*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/acidrain/acid-rain-program (July 22, 2021).

[202] Jonathan Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 ECOLOGY L.Q. 569, 577 (2001).

[203] *Id.* at 584.

policy explicitly authorizes emissions trading.[204] Operators of coal-fired power plants could install scrubbers to capture SO_2, switch to lower sulfur coal, continue emitting SO_2 at the same level and purchase allowances, reduce utilization of the plant, or replace the plant with generation that emits less (or no) SO_2.

Other environmental markets require translating environmental attributes into a common metric. Here, carbon markets that target multiple GHGs are informative.[205] As noted previously, GHGs result from different processes, have different sources, persist in the atmosphere for different periods of time, and have different warming potential. The common metric is the heat-trapping potential of each pollutant, using CO_2 as the baseline. According to the U.S. Environmental Protection Agency:

> The United States primarily uses the 100-year GWP as a measure of the relative impact of different GHGs. However, the scientific community has developed a number of other metrics that could be used for comparing one GHG to another. These metrics may differ based on timeframe, the climate endpoint measured, or the method of calculation.
>
> For example, the 20-year GWP is sometimes used as an alternative to the 100-year GWP. Just like the 100-year GWP is based on the energy absorbed by a gas over 100 years, the 20-year GWP is based on the energy absorbed over 20 years. This 20-year GWP prioritizes gases with shorter lifetimes, because it does not consider impacts that happen more than 20 years after the emissions occur. Because all GWPs are calculated relative to CO_2, GWPs based on a shorter timeframe will be larger for gases with lifetimes shorter than that of CO_2, and smaller for gases with lifetimes longer than CO_2. For example, for CH_4, which has a short lifetime, the 100-year GWP of 28–36 is much less than the 20-year GWP of 84–87. For CF_4, with a lifetime of 50,000 years, the 100-year GWP of 6630–7350 is larger than the 20-year GWP of 4880–4950.

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[204] *Id.* at 583–87.

[205] Carbon markets are not the only example of translating different environmental attributes to a common metric in order to facilitate trading. For example, wetlands mitigation banking focuses on acreage with certain characteristics—soil types, habitat potential, proximity to a body of water, etc. The environmental benefits of wetlands are also not fungible across geographic areas. Mitigating the loss of a wetland in Watershed A by constructing a new wetland in Watershed B, for example, would not replace the water filtration benefits in Watershed A. Furthermore, mitigation projects in different geographic areas may fail to replace the destroyed habitat if the priority species are unable to migrate to the new area or require different flora or fauna than is available in the new location. For a thorough analysis of the various considerations involved in creating environmental markets, see James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 611–13 (2000).

> Another alternate metric is the Global Temperature Potential (GTP). While the GWP is a measure of the heat absorbed over a given time period due to emissions of a gas, the GTP is a measure of the temperature change at the end of that time period (again, relative to CO_2). The calculation of the GTP is more complicated than that for the GWP, as it requires modeling how much the climate system responds to increased concentrations of GHGs (the climate sensitivity) and how quickly the system responds (based in part on how the ocean absorbs heat).[206]

Market-based plastics policies could incorporate either approach: focusing on a single metric or translating multiple attributes into a common metric. A key question is whether the primary concern is the volume of waste or the makeup of the plastic. A market-based approach to plastics pollution could focus on the volume of a particular type of plastics by, for example, capping the volume of plastics that enter the stream of commerce at a local, regional, national, or international level. Using volume as the metric would allow for creation of a common commodity, such as a ton of plastic, but it would not distinguish between the different uses and characteristics, nor would it account for the different densities of plastics or their relative contributions to pollution. The policy could apply to all plastics, certain characteristics of plastics, or plastics used for a particular purpose such as packaging or single-use bags.

Measurements for market-based plastics policies could create tradable commodities based on the social cost or certain environmental impacts. Alternatively, the policy could focus on the characteristics of the plastic product, such as the percent of recycled content, single-use versus reusable, or the ability to be recycled.[207] Each approach has tradeoffs. Focusing solely on recycled content of a plastic product, for example, creates incentives to increase recycling and reduce demand for hydrocarbons as plastics manufacturing feedstocks, but may not incentivize investment in alternatives that address other environmental concerns such as biodegradability. To put a finer point on it, the whale with plastics lodged in its digestive system or the turtle with its beak caught in plastic packaging do not care whether the plastic contains recycled content or not. Their concern is the volume of plastic and how the waste is managed.

Climate and energy policy also demonstrates that policymakers may implement multiple market-based policies that focus on different units of

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[206] *Understanding Global Warming Potentials*, U.S. ENV'T PROT. AGENCY: GREENHOUSE GAS EMISSIONS, https://www.epa.gov/ghgemissions/understanding-global-warming-potentials (Oct. 18, 2021).

[207] *See, e.g.*, Carriere & Beavers Horne, *supra* note 132, 10050–53 (proposing a market-based approach for mandating minimum recycled content for single-use plastic packaging).

measurement may operate in parallel. California and the states participating in the RGGI market also have clean energy policies that focus on other attributes—e.g., the amount of renewable energy generation or clean generation in the electricity mix.[208]

From a purely economic perspective, stacking these two policies may be inefficient, as the clean energy standard limits the flexibility that would otherwise be available under the cap-and-trade program.[209] A certain percentage of electricity generation must come from "clean" sources, rather than the most efficient way to comply with the emissions cap. From an environmental perspective, the stacking of different policies can accommodate multiple policy goals.

2. *Setting the Price or Pollution Limit*

Policymakers may set the price using an estimate of the social cost, a "target-consistent" approach that starts with a pollution reduction goal and sets the price necessary to achieve the goal, or set at a level that is deemed politically feasible.

Perhaps the best-known effort to calculate social costs of pollution is the federal social cost of carbon (SCC), first developed by an interagency working group (IWG) during the Obama administration.[210] There, the IWG considered changes in atmospheric emissions concentrations of carbon dioxide, how the atmospheric emissions concentrations affect temperature shifts, and how temperature shifts result in economic damages.[211] The resulting SCC is an average estimate of the annual marginal impacts caused

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[208] In addition to the state cap-and-trade program, California has a statutory mandate of 100% zero carbon emissions by December 31, 2045. California Renewables Portfolio Standard Program: Emissions of Greenhouse Gases, S. B. No. 100 § 5 (Cal. 2018). *See also Renewable & Clean Energy Standards*, NC CLEAN ENERGY TECH. CTR. (Sept. 2020), https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/2020/09/RPS-CES-Sept2020.pdf (showing that states participating in RGGI have also implemented additional clean energy policies).

[209] Neal J. Cabral, *The Role of Renewable Portfolio Standards in the Context of a National Carbon Cap-and-Trade Program*, 8 SUSTAINABLE DEV. L. & POL'Y 13, 14 (2007) ("Because RPS programs seem largely intended to reduce carbon emissions, despite the fact that they do not actually target carbon emissions, but rather fuel choice, their approach is a potentially inefficient command-and-control mandate at odds with a market-based cap-and-trade program. Market-based cap-and-trade programs hold, as their fundamental premise, that allowing the regulated community to determine its own solutions to meet a mandatory emissions cap is far more cost-effective and more certain than a one-size fits all series of command-and-control mandates, which instead set specific performance or technology standards.").

[210] INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 1 (2010). The Interagency Working Group on Social Cost of Carbon was re-named the Interagency Working Group on Social Cost of Greenhouse Gases beginning in August 2016. *See* NAT'L ACADS. OF SCIS., ENG'G & MED., VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE xvi (2017) (noting such change in the IWG).

[211] INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 210, at 5.

by an additional unit of carbon emissions, rather than an average estimate of the average damages of all carbon emissions ever emitted.[212]

The dramatic difference between the Obama administration's estimated $45 per ton federal SCC for the year 2020 and the Trump administration's $1–$6 per ton SCC shows the inherent value choices associated with determining the social cost of pollution.[213] While both administrations used the IWG's integrated assessment models, the Trump administration considered only domestic impacts of climate change, in contrast to the Obama administration's focus on domestic and international impacts.[214] The Trump administration also prescribed discount rates of 3 and 7 percent, rather than a range of discount rates used to determine the SCC during the Obama administration.[215]

Current plastics pricing policies do not attempt to quantify the full marginal costs of plastics. Scholarship analyzing the social costs of plastics evaluate impacts in different locations using different methodologies.[216] There is no consensus about an approach for estimating social costs and there is insufficient information about the full social and environmental impacts of plastics pollution to inform the analysis.[217]

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[212] ILIANA PAUL, PETER HOWARD & JASON A. SCHWARTZ, INST. FOR POL'Y INTEGRITY, THE SOCIAL COST OF GREENHOUSE GASES AND STATE POLICY: A FREQUENTLY ASKED QUESTIONS GUIDE 17 (2017).

[213] Jason Bordoff, *Trump vs. Obama on the Social Cost of Carbon–And Why It Matters*, WALL ST. J.: EXPERTS BLOG (Nov. 15, 2017, 1:04 PM), https://blogs.wsj.com/experts/2017/11/15/trump-vs-obama-on-the-social-cost-of-carbon-and-why-it-matters/; INTERAGENCY WORKING GRP. ON SOC. COST OF GREENHOUSE GASES, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 4 tbl.ES-1 (2016); OFF. OF AIR QUALITY PLANNING & STANDARDS, OFF. OF ATMOSPHERIC PROGRAMS & OFF. OF POL'Y, U.S. ENV'T PROT. AGENCY, REGULATORY IMPACT ANALYSIS FOR THE REVIEW OF THE CLEAN POWER PLAN: PROPOSAL 44 tbl.3-7 (2017) [hereinafter REGULATORY IMPACT ANALYSIS].

[214] Sarah Krakoff & Shannon Roesler, *Environmental Justice and Environmental Sustainability: Beyond Environment and Beyond Law*, *in Environmental Law. Disrupted.*, 49 ENV'T L. REP. 10038, 10050–51 (2019) ("[T]he Administration's new $1-$7/ton social cost of carbon completely ignores the costs of global warming outside the United States, an isolationist approach to a quintessentially global problem.").

[215] REGULATORY IMPACT ANALYSIS, *supra* note 213, at 44 tbl.3-7; Katherine A. Trisolini, *Efficiency Gatekeepers, the Social Cost of Carbon, and Post-Trump Climate Change Regulation*, 91 TEMP. L. REV. 261, 302–05 (2019).

[216] *See, e.g.*, Lau et al., *supra* note 4, at 1 ("The lower-bound estimate of the economic impact on costs of plastic pollution to fishing, tourism, and shipping have been estimated at $13 billion annually."); Beaumont et al., *supra* note 5, at 193 (2019) (estimating that the economic cost of the impact of marine plastic on marine natural capital would be between $3,300 and $33,000 in 2011 dollars); Roy Brouwer et al., *The Social Costs of Marine Litter Along European Coasts*, 138 OCEAN & COASTAL MGMT. 38, 38 (2017) (evaluating "the social costs of marine debris washed ashore and litter left behind by beach visitors along different European coasts").

[217] *See, e.g*, KARASIK ET AL., *supra* note 21, at 82 ("[T]here is limited knowledge about the (internal or external) costs of plastic bag pollution as well as other environmental and social costs of consumption that are not included in the price that the retailers pay for plastic bags, so it is not possible to set the price for plastic bags at the marginal social cost."); Stephanie L. Wright & Frank J. Kelly, *Plastic and Human*

Furthermore, there are numerous challenges with quantifying the social cost of plastics pollution.[218] Reliable data about health and ecological impacts of plastics pollution is not available. Even if the data were available, a social cost calculus that prioritizes anthropocentric impacts may severely undervalue the benefits of mitigating plastics pollution. A robust SCC that accounts for uncertainties regarding discount rates and includes both domestic and international impacts is an effective metric for designing climate policy.[219] Unabated GHG emissions pose existential threats to human life, and therefore the social cost of those harms produces an emissions cost that would have an immediate impact on energy production and consumption.[220] Energy resources with little or no GHG emissions would be more competitive, and a high emissions cost should drive investment in developing additional lower-emitting resources.[221] The impact of plastics pollution may have significant economic effects on some sectors, such as local tourism or fisheries. Compared to climate change, however, plastics pollution has far less of a direct effect on services and society.[222] Many of the impacts of plastics pollution affect biodiversity and ecosystems, complicating efforts to quantify the social costs of plastics pollution.[223]

It is not necessary to pinpoint a social cost in order for pollution pricing to reduce the impacts of plastics, but pollution pricing should increase the cost of a plastic product which could make alternatives to plastic more cost effective. The challenges and uncertainty with calculating an SCC led the United Kingdom (UK) to shift from a "damage cost estimate[]" approach to a target-consistent approach to assessing the value of GHG abatement.[224] The target-consistent approach estimates of the abatement costs are

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Health: A Micro Issue?, 51 ENV'T SCI. & TECH. 6634, 6634 (2017) (noting that "microplastics and human health is an emerging field").

[218] *See supra* text accompanying notes 211–215.

[219] Geoffrey Giller, *The Social Cost of Carbon Is Still the Best Way to Evaluate Climate Policy*, YALE SCH. OF THE ENV'T (Aug. 23, 2021), https://environment.yale.edu/news/article/social-cost-of-carbon-still-best-way-to-evaluate-climate-policy.

[220] William D. Nordhaus, *Revisiting the Social Cost of Carbon*, 114 PROC. NAT'L ACAD. SCIS. 1518, 1518 (2017) ("The most important single economic concept in the economics of climate change is the social cost of carbon . . . .").

[221] KEOHANE & OLMSTEAD, *supra* note 135, at 179–84.

[222] *Plastic Waste and Climate Change—What's the Connection?*, WORLDWIDE WILDLIFE FUND AUSTL. (June 30, 2021), https://www.wwf.org.au/news/blogs/plastic-waste-and-climate-change-whats-the-connection#gs.cfx601 (explaining the connection between plastic waste and climate change in an interview with Kerri Major, Engagement Manager of Partnerships and Innovation at WWF Australia).

[223] *See* Beaumont et al., *supra* note 5, at 194 (finding that even "conservatively" calculating the economic impact of ocean plastics pollution costs $3,300 to $33,000 per tonne of marine plastic per year); Tamara S. Galloway, Matthew Cole & Ceri Lewis, *Interactions of Microplastic Debris Throughout the Marine Ecosystem*, 1 NATURE ECOLOGY & EVOLUTION 0116-1 *passim* (2017) (discussing the ecological impacts of plastic on marine life).

[224] U.K. DEP'T OF ENERGY & CLIMATE CHANGE, CARBON VALUATION IN UK POLICY APPRAISAL: A REVISED APPROACH 21 (2009).

necessary to meet specific emissions reduction targets.[225] Calculating the price requires comparing emissions projections under a business-as-usual scenario with the emissions reductions goal. This gap between business-as-usual scenarios and the target emission levels represents the emission reductions needed to meet the target goals in each of the years.[226] Policymakers then use cost curves to estimate the price necessary to achieve the reductions.[227]

A target-based approach for plastics, therefore, could be more effective than attempting to base policy on a social cost analysis. The target could focus on an amount of pollution abatement or a price that produces revenue to develop alternative products and improve waste management programs.

3. *Choosing Between Price Certainty or Quantity Certainty*

The concern with climate change is the total atmospheric concentration of GHGs and policy measures often focus on specific metrics such as limiting the average global temperature increase to no more than two degrees Celsius.[228] The scientific data that the severity of climate change impacts will increase as the concentration increases, and concerns about an atmospheric tipping point that could result in irreversible global impacts, have led many policymakers and stakeholders to prioritize quantity certainty.[229] Many stakeholders and policymakers also viewed carbon markets as the more politically-viable option.[230]

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[225] Noah Kaufman et al., *A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices*, 10 NATURE CLIMATE CHANGE 1010, 1010–11 (2020).

[226] U.K. DEP'T OF ENERGY & CLIMATE CHANGE, *supra* note 224, at 15–18.

[227] *Id.* at 17.

[228] *See* Paris Agreement, *supra* note 186, art 2.1(a) (stating that the Paris Agreement aims to "hold[] the increase in the global average temperature to well below 2°C above pre-industrial levels and [to] [pursue] efforts to limit the temperature increase to 1.5°C above pre-industrial levels").

[229] CTR. FOR CLIMATE & ENERGY SOLS., *Cap and Trade Basics*, https://www.c2es.org/content/cap-and-trade-basics (last visited Sept. 17, 2021) (a cap-and-trade program "may be the preferable policy when a jurisdiction has a specified emissions target"); Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENV'T L. REV. 293, 298 (2008) ("Overall, a cap-and-trade system provides certainty regarding emissions from regulated sources because *aggregate* emissions from all regulated entities cannot exceed the total number of allowances."). Although emissions certainty is a key trait of a cap-and-trade program, it is possible to increase emissions certainty through a carbon tax. *See, e.g.*, BRIAN MURRAY, WILLIAM A. PIZER & CHRISTINA REICHERT, NICHOLAS INST. FOR ENV'T POL'Y SOLS., POLICY BRIEF NI PB 16-03, INCREASING EMISSIONS CERTAINTY UNDER A CARBON TAX 2–4 (2016) (discussing options to incorporate emissions certainty into carbon tax policies, including tax adjustments, regulatory backstops, and spending tax revenue to reduce emissions); Katharine Hayhoe et al., *Our Changing Climate*, *in* II IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES: FOURTH NATIONAL CLIMATE ASSESSMENT 100, 120 (David Reidmiller et al. eds., 2018) (discussing threats of a tipping point).

[230] *See, e.g.*, Charles Frank, *Pricing Carbon: A Carbon Tax or Cap-and-Trade?*, BROOKINGS (Aug. 12, 2014), https://www.brookings.edu/blog/planetpolicy/2014/08/12/pricing-carbon-a-carbon-tax-or-cap-and-trade (discussing opposition to carbon taxes and the political viability of cap-and-trade markets for electric power plants).

The type of certainty for plastics policy depends on the goals, as discussed previously in this Subpart.[231] Achieving specific reductions in the amount of plastic production, the amount of non-recycled plastic (post-consumption), or the total volume of plastic production or consumption would each call for a quantitative-based approach. Similar to climate policy, a tax on plastics may incentivize different behaviors depending on the amount of the tax, the cost of alternatives, and the ability to pass costs through to consumers. However, it would not ensure a reduction in the volume of plastic production, consumption, or waste.

Economic and environmental certainty are not the only determining factors that guide the choice between pollution taxes and cap-and-trade markets. For example, trading may allow entities producing plastics with higher social benefit to purchase allowances and continue producing.[232] Alternatively, a market- or tax-based program could exempt certain types of plastics altogether.[233] Administrative and monitoring costs may also influence the policy instrument choice. A pollution tax, for example, does not require trading platforms. Nor does it raise concerns about market manipulation, requiring a potentially costly government program to monitor market transactions.[234]

4. *Assigning Compliance Obligations*

Assigning compliance obligations for unilateral market-based plastics policies could be particularly complex. Climate policies require compliance by upstream sources of emissions, such as power plants, refineries, and manufacturers.[235] This applies the policy to fewer sources and those sources are already subject to multiple regulatory requirements, including some who are covered by market-based programs. It is easier for regulators to monitor these sources and take enforcement action if necessary.

Policymakers could place the compliance obligation with manufacturers of plastic resins, manufacturers of plastic products, or retailers selling the

[231] *See supra* text accompanying notes 165–166.

[232] *See, e.g.*, Stavins, *supra* note 229, at 298 (explaining that, under an emissions market, "the cap is placed only on aggregate emissions and imposes no particular limits on emissions from any given firm or source"). This compliance flexibility has been the source of significant critiques of emissions markets. For an example of such a critique, see Alice Kaswan, *Environmental Justice and Domestic Climate Change Policy*, 38 ENV'T L. REP. 10287, 10301 (2008).

[233] For example, the RGGI market exempts electric generators that are not capable of producing a minimum of 25 megawatts. *Elements of RGGI*, REG'L GREENHOUSE GAS INITIATIVE, https://www.rggi.org/program-overview-and-design/elements (last visited Sept. 17, 2021). Similarly, the RGGI program only applies to electricity generation. *Id.*

[234] Jonas Monast, *Climate Change and Financial Markets: Regulating the Trade Side of Cap and Trade*, 40 ENV'T L. REP. 10051, 10061 (2010) (evaluating options to oversee carbon markets as financial markets).

[235] This is the approach taken with the California Cap-and-Trade Program, the RGGI, the EU Emissions Trading Scheme, and the Acid Rain Program. *See supra* notes 201, 230 and accompanying text; *infra* text accompanying notes 256–262.

plastic products to customers. The choice would depend, at least in part, upon the unit of measurement and the geographic scope of the policy. For example, most bag fees apply at the retail level. It would be difficult for retailers that sell multiple products with plastic packaging to verify the percent of virgin content in, or recyclability of, each product. Upstream manufacturers would be better suited to do so, but those manufacturers may not be located in a region with the compliance obligation.

5. *Avoiding Pollution Leakage*

The term "leakage" can have different meanings in the context of plastics policy. Plastics leakage can refer to the plastic waste discharged into the environment.[236] Leakage may also refer to product leakage, whereby a policy targeting a certain type of plastic can lead to increased use of alternative products that are not subject to the policy.[237] A third type of leakage that can arise with plastics policy is an increase in pollution in a sector or a location that is not covered by a pollution abatement policy.[238]

The primary leakage concerns with climate policy are emissions leakage across geography or leakage across sectors of the economy.[239] Because GHGs are globally-mixing, a policy that is limited to one jurisdiction could cause emitters to relocate or make polluters in other jurisdictions more cost-competitive.[240] The most straightforward response to leakage in these contexts is to design a policy with as broad a geographic and sectoral scope as possible.[241]

A border adjustment is a partial solution for international leakage concerns, as it can apply the compliance cost of a domestic policy to imported products.[242] This accounts for emissions associated with domestic consumption but does not apply to products sold in other countries.[243] If

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[236] KARASIK ET AL., *supra* note 21, at 14. This use of the term "leakage" is not limited to plastics policy. *See, e.g.*, Sudhanshu Pandey et al., *Satellite Observations Reveal Extreme Methane Leakage from a Natural Gas Well Blowout*, 116 PROC. NAT'L ACAD. SCIS. 26376, 26376 (2019) (referring to methane escaping from natural gas wells as "leakage").

[237] KARASIK ET AL., *supra* note 21, at 13 (noting that "consumption of alternatives to plastics targeted by a policy . . . is a key challenge").

[238] Stavins, *supra* note 229, at 311 (defining leakage as "market adjustments resulting from a regulation [that] lead to increased emissions from unregulated sources outside the cap that partially offset reductions under the cap").

[239] *Id.* Applying a carbon price to electricity, but not to heating fuels, is a situation that could cause leakage across economic sectors. Increased emissions from heating fuels could negate some of the emission reductions that may occur in the electricity sector. *Id.*

[240] *Id.*

[241] Jonathan B. Wiener, *Think Globally, Act Globally: The Limits of Local Climate Policies*, 155 U. PA. L. REV. 1961, 1967 (2007) (arguing that emissions leakage is "perhaps [the] most important" disadvantage of subglobal climate policies).

[242] *See, e.g.*, American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. § 768(a)(1)(E) (2009) (applying a carbon border adjustment on imported products).

[243] *Id.*

those other countries do not have climate policies, or have less stringent policies, global emissions caused by the product could still rise.

Domestic price focused on consumption can apply to plastics produced domestically or imported. Price on production could apply directly to domestic producers and apply as a border adjustment for imports. The importance of leakage, therefore, turns on the purpose of the policy. If the purpose is to decrease local pollution or to incentivize the use of alternatives for domestic use, then domestic policy may be enough. If the purpose is to address any of the collective action problems identified in Part I, the policy should account for leakage.[244]

If the primary concern is the product rather than the pollution, it is easier for a country to apply a price to imports. That may reduce competitiveness of virgin plastics within the country and create revenue to fund R&D. It does not necessarily impact total production, so there is still an argument for multinational coordination.

Regarding sectoral leakage, a pollution price is agnostic about production that is not subject to the policy. For plastics, this could also apply to concerns about product leakage. If the policy aims at a particular type of plastic, it would be possible for manufacturers to develop alternative products that are not subject to the policy. These alternatives could have more serious environmental impacts than the products they replaced.

6. *Choosing Between Top-Down and Bottom-Up Governance*

The focus on a uniform, legally-binding agreement with uniform obligations almost derailed the international climate negotiations.[245] Achieving unanimity proved to be unrealistic, with uniform commitments a particular sticking point.[246] The United States remained unwilling to accept the Kyoto Protocol's distinction between developed and developing countries.[247] Numerous developing countries argued that they should not face the same emission constraints as countries like the United States, which are responsible for the majority of GHGs currently affecting the climate and that had already benefitted economically from those emissions.[248]

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[244] For example, the United States is a direct source of plastic pollution and the second largest global exporter of plastic waste. Lavender Law et al., *supra* note 57, at 1.

[245] *See supra* Part III.B. *See also* David G. Victor, *What the Framework Convention on Climate Change Teaches Us About Cooperation on Climate Change*, 4 POL. & GOVERNANCE 133, 134 (2016) (discussing the challenges of a legally binding, universal agreement).

[246] Daniel Bodansky, *The Copenhagen Climate Change Conference: A Postmortem*, 104 AM. J. INT'L L. 230, 233 (2010).

[247] *Id.*

[248] *Id.* at 232 ("[D]eveloping countries continue[d] to argue, as they [had] done since the negotiations began back in 1991, that they are not historically responsible for the climate change problem, have less capacity to respond to it, and should therefore not be expected to undertake specific international commitments to reduce emissions.").

In the aftermath of the 2009 UNFCCC Conference of Parties, international negotiators shifted away from the preferred top-down, uniform agreement and embraced the heterogeneous, bottom-up framework that countries ultimately adopted in the 2015 Paris Agreement.[249] The success of the UNFCCC process now depends upon member countries' willingness to meet their "common but differentiated responsibilities," including increasing the stringency of their respective commitments.[250] Negotiators working toward a regional or global plastics pollution agreement face a similar set of choices.[251]

A key question for policymakers is whether the environmental and economic benefits of uniformity outweigh the challenges of reaching agreement or the risk that achieving broad agreement would result in decreased stringency of the policy.[252] A single set of rules may be economically efficient, prevent forum shopping by firms with compliance obligations, and provide a platform for adjusting the policy over time. It could also expose the policy to political vulnerabilities if a country representing a large source of the problem withdraws from the agreement, such as the Trump administration's decision to withdraw from the Paris Agreement.[253]

7. *Facilitating Program Linkage*

There are numerous examples of carbon markets linking with one another. For example, California designed its carbon market while also engaging with other Western states regarding a regional carbon market, and state regulations specify requirements for market linkage.[254] The California market linked its market with Quebec's in 2013, and briefly linked with Ontario's carbon market in 2018.[255] The RGGI operates as a linked system

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[249] Charles F. Sabel & David G. Victor, *Governing Global Problems Under Uncertainty: Making Bottom-Up Climate Policy Work*, 144 CLIMATIC CHANGE 15, 16 (2017) ("The top-down world has long been assumed as the first best strategy for solving serious global problems."). Climate policy in the United States followed a similar trajectory from the initial focus on top-down to bottom-up approaches. Monast, *supra* note 10, at 185–205.

[250] Paris Agreement, *supra* note 186, art. 4.

[251] RAUBENHEIMER & URHO, *supra* note 9, at 35–36.

[252] Victor, *supra* note 245, at 134.

[253] Lisa Friedman, *U.S. Quits Paris Climate Agreement: Questions and Answers*, N.Y. TIMES (Jan. 20, 2021), https://www.nytimes.com/2020/11/04/climate/paris-climate-agreement-trump.html. The United States subsequently rejoined the agreement after President Biden took office. Presidential Statement on Acceptance of the Paris Agreement on Climate Change on Behalf of the United States, 2021 DAILY COMP. PRES. DOC. 1 (Jan. 20, 2021).

[254] Monast, *supra* note 10, at 191–92; CAL. GOV'T CODE § 12894 (West 2021) (listing the findings that the governor must make before California's carbon market may link with another jurisdiction).

[255] *Program Linkage*, CAL. AIR RES. BD., https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-linkage (last visited Nov. 21, 2021). The market linkage between California and Ontario ended when Ontario repealed its cap-and-trade program. *Id.*

rather than a single, top-down market.[256] Each state participating in RGGI adopts its own legislation and regulations that allow the state to participate in the market. The individual state laws are consistent with the RGGI model rule, including an emissions cap, trading rules, and tracking system requirements.[257] The result is a common set of rules for the regional market, rather than a single, top-down program.[258]

The preceding examples focus on existing linked carbon markets that coordinated with prospective partners while implementing the market. Jurisdictions acting unilaterally may also facilitate future linkage, but their initial policy design choices may affect whether linkage is possible. The California Cap-and-Trade Program and RGGI are not compatible without significant changes on the part of one or both programs. California's market covers multiple sectors of the economy and includes specific rules for domestic and international carbon offset credits.[259] The RGGI market, on the other hand, only covers emissions from the electricity sector and includes a different set of rules and restrictions for carbon offsets.[260]

Policymakers in different jurisdictions may streamline future linkage by adopting common market design choices. For example, the Clean Power Plan, the Obama-era Clean Air Act rule limiting GHG emissions from existing power plants, included "trading ready" options that identified regulations a state could implement that would facilitate trading with other states.[261]

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[256] The states participating in RGGI agree to their respective emission reduction obligations and codify a common set of market rules rather than opting into a single market system. Wiseman & Osofsky, *supra* note 163, at 220–21. This scheme avoids Compact Clause vulnerabilities. Notably:

> The states created a 501(c)(3) nonprofit organization to develop and support this initiative. This organization has no 'regulatory or enforcement authority,' as states that are part of the initiative retain independent rulemaking and enforcement authority and simply adopt model rules to implement RGGI, but it conducts much of the technical and operational work required to make RGGI run smoothly.

Id. at 221.

[257] For example, Virginia is in the process of joining RGGI. VA. CODE ANN. § 10.1-1330 (2021); 9 VA. ADMIN. CODE § 5-140-6010 (establishing a CO_2 Budget Trading Program).

[258] For a compilation of state laws and regulations for the RGGI program, see *State Statutes & Regulations*, REG'L GREENHOUSE GAS INITIATIVE, https://www.rggi.org/program-overview-and-design/state-regulations (last visited Nov. 21, 2021).

[259] *See California Cap and Trade*, CTR. FOR CLIMATE & ENERGY SOLS., https://www.c2es.org/content/california-cap-and-trade (last visited Sept. 16, 2021) (summarizing the California carbon market); *Compliance Offset Protocols*, CAL. AIR RES. BD., https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/compliance-offset-protocols (last visited Sept. 16, 2021) (summarizing the registration process for offset projects and providing links for further information).

[260] *Elements of RGGI*, *supra* note 233.

[261] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,661, 64,735 (Oct. 23, 2015) (repealed 2019).

Alternatively, a jurisdiction may incorporate design choices of markets that are already operating.[262]

Linking a tax-based approach avoids many of the complications that arise with pollution markets. Jurisdictions can apply a different tax to the same types of plastics or apply the same tax to different plastics. The differences would not interfere with a single jurisdiction's policies, but it could lead to different behaviors among firms. A tax on plastics production could incentivize manufacturing to relocate to areas with low or no pollution tax. Similarly, different taxes focused on a product (e.g., packaging) or on post-consumer waste could incentivize the sale of certain plastics in different places. The impact of the product-based tax or post-consumer waste tax would depend on the levels of the tax and the number of jurisdictions with taxes. If few jurisdictions adopt the tax, or the majority of jurisdictions with taxes choose negligible prices, the policies may have little impact on overall plastics production. Choosing common pollution prices and covered entities could help avoid the incentives for relocation and help ensure effectiveness of the policies.

CONCLUSION

Like climate change, a market-based policy response to the plastics pollution problem would be more efficient, and possibly more effective, if there were a broad regional or global response that placed the compliance obligation on upstream producers of plastic resins or manufacturers of plastic products. This would address concerns about production leakage and create consistent incentives and regulatory requirements for producers. However, a global approach could suffer from the same limitations as the global efforts to address climate change, particularly the risk of a lack of consensus and pressures to make the policy less stringent and, thus, less effective.

The nature of plastics pollution allows more flexibility with the policy response than do globally mixing pollutants like GHGs. An effective global agreement may be preferable, but it is possible to achieve local and regional benefits even if other countries refuse to act. Also, although plastic pollution is an ever-growing problem, there is not a tipping point that could result in irreversible global impacts, reducing the importance of policy uniformity. Different countries could therefore pursue different responses. They could also design programs that could link to one another. Here, a plastics tax could be attractive, as linking would require agreement on issues such as pricing, monitoring, and enforcement, but would not require the complex

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[262] California regulations and European Union Directives provide guidance for jurisdictions seeking to link with their respective carbon markets. CAL. GOV'T CODE § 12894 (West 2021); Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 Amending Directive 2003/87/EC so as to Improve and Extend the Greenhouse Gas Emission Allowance Trading Scheme of the Community, 2009 O.J. (L 140) 63, 64; *International Carbon Market*, EUR. COMM'N, https://ec.europa.eu/clima/policies/ets/markets_en (last visited Sept. 17, 2021).

rules necessary to facilitate multijurisdictional markets. Alternatively, carbon taxes could operate in parallel with one another, with import tariffs leveling the playing field for domestic firms. Differences in price and scope could affect firms' behavior, but the benefits of unilateral action may outweigh the inefficiencies or potential for production leakage.

Policymakers could design pricing policies to complement other measures to reduce plastics pollution. For example, the revenue could fund research into alternative products, new waste management technologies, or consumer incentives. Revenue could also support cleanup efforts and economic development in areas suffering from plastics pollution.