Title

Making Net Zero Matter

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Making Net Zero Matter

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Abstract

In recent months, dozens of countries and thousands of businesses have pledged to achieve net zero greenhouse gas emissions. However, net zero often means different things to different entities, and it is often uncertain how net zero pledges—which set targets years or decades from the present—will be met. This Article considers the motivations behind net zero pledges, highlights the underappreciated role of carbon removal in net zero efforts, and identifies mechanisms for encouraging the accomplishment of net zero goals. Two key strategies are essential to making net zero targets matter. First, society should develop and implement accountability and enforcement mechanisms to promote follow through on net zero commitments. These mechanisms include disclosure standards, benchmarks, contractual arrangements, and legal claims under securities and consumer protection laws. Second, net zero pledges should incorporate distinct targets for emissions reduction and carbon removal. Carbon mitigation and carbon removal differ in significant ways with respect to verifiability, permanence, readiness, and risks. Distinguishing carbon mitigation and carbon removal in

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net zero goals is essential to avoid undermining efforts to achieve climate goals, shifting the burdens of climate action to vulnerable populations or future generations, and increasing societal, health, and environmental risks.

INTRODUCTION

In recent months, net zero has become all the rage in climate policy. Dozens of countries—representing over two-thirds of global carbon emissions—have declared their intent to achieve net zero greenhouse gas (GHG) emissions in the coming decades.[1] Hundreds of cities and over three thousand businesses have joined Race to Zero, a global collection of net zero commitments from entities responsible for a quarter of global CO_2 emissions.[2] Many

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[1] *See* INT'L ENERGY AGENCY, NET ZERO BY 2050 32 (2021) [hereinafter IEA, NET ZERO] (reporting that countries with net zero pledges account for around 70 percent of global CO_2 emissions); *Net Zero Tracker*, CLIMATE WATCH, https://perma.cc/V8RK-3U9Q (last visited Jan. 16, 2022) (reporting that seventy-four parties, representing eighty-one countries and 73.8 percent of global GHG emissions, have adopted net zero targets).

[2] *See* UNFCCC, *Race to Zero Campaign*, https://perma.cc/MS2F-SM2V (last visited Jan. 16, 2022) (reporting that "733 cities, 31 regions, 3,067 businesses, 173 of the biggest investors, and 622 Higher Education Institutions" have joined the Race to Zero campaign); ALBERTO CARRILLO PINEDA ET AL., SCI. BASED TARGETS INITIATIVE, FOUNDATIONS FOR SCIENCE-BASED NET-ZERO TARGET SETTING IN THE CORPORATE SECTOR 5 (2020) [hereinafter SBTI] (same); DATA-DRIVEN ENVIROLAB & NEWCLIMATE INST., ACCELERATING NET ZERO 4 (2020) [hereinafter NCI, ACCELERATING NET ZERO] (detailing the global shift towards net-zero GHG emission pathways).

of the world's best-known brands—such as Apple, Facebook, Ford, and McDonald's—are among the companies that have made net zero commitments.[3]

Net zero targets can take the form of firm commitments and binding laws.[4] They also may appear as aspirational statements and nonbinding policy pledges.[5] In theory, the achievement of net zero targets can be measured and assessed more readily than broad commitments to environmental sustainability. Nonetheless, it is often uncertain how nations, cities, and businesses will achieve net zero. Net zero commitments—which set targets years or decades from the present—often lack detail regarding implementation measures and interim goals.[6] Furthermore, carrying out those commitments will not be easy.

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[3] *See* NCI, ACCELERATING NET ZERO, *supra* note 2, at 13–14 (listing McDonald's, Apple, and Facebook as companies who have announced net zero commitments); Leighton Schneider, *Ford Announces New Carbon Neutral Targets*, ABC NEWS (Apr. 2, 2021), https://perma.cc/7CRJ-K5KD (describing Ford's goal to become carbon neutral by 2050).

[4] *See* Kelly Levin et al., *Designing and Communicating Net-Zero Targets* 7–8 (World Res. Inst., Working Paper, July 2020) [hereinafter Levin et al., *Designing and Communicating*] (listing the ways net zero targets are established).

[5] *See id.* at 8.

[6] *See* NEWCLIMATE INST. & DATA-DRIVEN ENVIROLAB, NAVIGATING THE NUANCES OF NET-ZERO TARGETS 1, 3 (2020) [hereinafter NCI, NAVIGATING THE NUANCES] (stating that only "a limited number of subnational governments and companies" have created action plans for their net-zero goals and "[o]nly 33 percent of subnational governments' and 8 percent of companies' net-zero targets include interim targets to chart a decarbonisation pathway").

It will require wholesale changes in production processes, energy systems, transportation modes, and economic systems to mitigate (i.e., reduce) GHG emissions.[7] At a global level, net zero will require significant levels of carbon removal from the atmosphere to counterbalance residual GHG emissions.[8] International policymakers have implicitly acknowledged this fact but have yet to plan accordingly.[9] Even national net zero commitments will have to rely on carbon removal or carbon credits, as will many subnational and private commitments.[10]

This Article considers the motivations behind net zero pledges, highlights the underappreciated role of carbon removal in net zero efforts, and identifies mechanisms for encouraging the accomplishment of net zero goals.[11] While net zero pledges are increasingly

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[7] See Felix Schreyer et al., *Common but Differentiated Leadership: Strategies and Challenges for Carbon Neutrality by 2050 Across Industrialized Economies*, 15 ENV'T. RES. LETTERS 114016, at 3 (2020).

[8] *See id.* at 7–8 (projecting that carbon removal must compensate for 10 percent or more of 2020-level GHG emissions in the U.S., European Union, Japan, and Australia for each region to achieve carbon neutrality by 2050).

[9] *See* Oliver Geden et al., *Targeting Carbon Dioxide Removal in the European Union*, 19 CLIMATE POL'Y 487, 488 (2019). Even the European Union, a leader in international climate policy, has been relatively silent on carbon removal. *Id.* at 488.

[10] *See* IEA, NET ZERO*, supra* note 1, at 34–36 (detailing the need and use of carbon offsets in net zero pledges).

[11] For discussions of the broader question of designing and implementing net zero targets, see Levin, *supra* note 4, and SBTI, *supra* note 2.

important in the battle against climate change, their meaning is often indeterminate and varied. Fleshing out net zero commitments, including their scope, pathways to their achievement, and reliance on carbon removal, is essential. To ensure that sufficient carbon removal occurs without undermining GHG mitigation efforts, policymakers and corporations should set out distinct goals for emission reduction and carbon removal. To hold companies accountable for net zero pledges, governments and other actors should develop and implement disclosure standards, benchmarks, contractual arrangements, and other appropriate mechanisms. And to hold governments accountable for their pledges, a range of litigation tools may be necessary.

Part I offers background on net zero targets, including efforts to mitigate climate change, potential methods to remove CO_2 from the atmosphere, and an overview of net zero commitments by governments and private entities. Part II explores whether these commitments are likely to contribute to combating climate change by considering the motivations leading to their adoption. Part III identifies various mechanisms for reinforcing net zero pledges through transparency and accountability measures, stakeholder and public pressure, and litigation. Part IV turns to a basic question of net zero design—whether net zero pledges should include distinct carbon mitigation and carbon removal goals—and answers that question affirmatively in light of important differences between the two and the danger that carbon removal may undermine carbon mitigation efforts.

I. BACKGROUND ON NET ZERO

A. *Efforts to Mitigate Climate Change*

Historically, climate change policy has concentrated on mitigation—i.e., reducing or eliminating GHG emissions.[12] Mitigation includes replacing fossil fuels with renewable energy sources, adopting more energy efficient processes, and capturing and storing emissions from industrial processes.[13] Despite some success in mitigation efforts, global GHG emissions continue to rise—aside from a brief drop during the COVID-19 pandemic—and climate change effects continue to intensify.[14] Current emissions are estimated at over fifty gigatons (Gt) of carbon dioxide equivalent per year.[15] Growing recognition of climate change's urgency has expanded support for the concept of net zero emissions.[16] In a net zero world,

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[12] *See, e.g.*, Schreyer, *supra* note 7 (examining region-specific mitigation strategies in four industrial countries).

[13] *See* S. JULIO FRIEDMANN ET AL., NET-ZERO AND GEOSPHERIC RETURN 17–20 (2020).

[14] *See* Benjamin Storrow, *'Worrying Resurgence': CO_2 Rises After Pandemic Dip*, CLIMATEWIRE (Mar. 3, 2021, 6:50 AM), https://perma.cc/2W9N-SEZM.

[15] *See* U.N. ENV'T PROGRAMME, EMISSIONS GAP REPORT 2020 xiv (2020) (reporting that in 2019 global GHG emissions reached around 52.4 gigatons of equivalent carbon dioxide); *see also* U.N. ENV'T PROGRAMME, EMISSIONS GAP REPORT 2021, at 5 fig.2.1 (2021) [hereinafter EMISSIONS GAP REPORT 2021] (graphing the rise in total GHG emissions from 1970 to 2020).

[16] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 1. Net zero, which typically refers to a balancing of emissions and removals of *all* GHGs, is sometimes used

global GHG emissions for a given period would be counterbalanced by removals of GHGs from the atmosphere during that same period.[17]

The 2015 Paris Agreement established a baseline goal of limiting average global temperature rise to 2°C and a further goal of limiting temperature rise to 1.5°C.[18] Achieving either of these goals will require human society to achieve net zero emissions during the 21st century.[19] The Paris Agreement directly incorporates the net zero concept in its call for

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interchangeably with the terms "carbon neutrality" and "climate neutrality." NCI, ACCELERATING NET ZERO, *supra* note 2, at 9. However, net zero is easier to achieve than climate neutrality but more difficult to achieve than carbon neutrality. Carbon neutrality refers to a balancing of emissions and removals of carbon dioxide, the most significant GHG. *See* SBTI, *supra* note 2, at 48 (noting that carbon neutrality and "net-zero CO_2 emissions" are analogous). Climate neutrality, which refers to "a state where human activities result in no net effect on the climate system," requires net-zero GHG emissions *and* avoidance of any bio-geophysical changes to climate due to human activities. *Id.* at 48.

17 *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 6 ("The concept of balancing emissions and removals is akin to reaching net-zero emissions.").

18 Adoption of the Paris Agreement to the United Nations Framework Convention on Climate Change art. 2.1(a), Dec. 12, 2015, T.I.A.S. No. 16-1104, U.N. Doc. FCCC/CP/2015/L.9 [hereinafter Paris Agreement].

19 *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5°C, at 95 (2018) [hereinafter IPCC] (stating that "[l]imiting warming to 1.5°C implies reaching net zero CO_2 emissions globally around 2050").

parties "to undertake rapid reductions [in emissions] . . . so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century."[20] Sinks include natural processes that remove and store GHGs from the atmosphere, such as tree growth, as well as manmade processes, such as underground carbon storage.[21] The Paris Agreement does not specify whether the balance between emissions and removals is to be achieved globally or nationally.[22] However, stabilizing the global climate system would at a minimum require a global balance.[23] As such, the growing recognition that

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[20] Paris Agreement art. 4.1, *supra* note 18. The 1992 U.N. Framework Convention on Climate Change called more generally for "limiting . . . emissions of greenhouse gases *and* protecting and enhancing . . . greenhouse sinks and reservoirs." United Nations Framework Convention on Climate Change art. 4.2(a), May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 164 (emphasis added).

[21] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 6 (defining a sink as a "physical unit or process that removes and stores a GHG from the atmosphere," including photosynthesis and air capture).

[22] *See* J. Fuglestvedt et al., *Implications of Possible Interpretations of "Greenhouse Gas Balance" in the Paris Agreement*, 376 PHIL. TRANS. R. SOC. A 20160445, at 4 (2018) (discussing the various ways "balance" can be interpreted in the Paris Agreement).

[23] *See id.* at 4. The existence of multiple GHGs and various potential interpretations of "balance" complicate the task of determining whether the specified balance has been achieved. *See id.* at 2–8.

achieving the 1.5°C goal likely requires balancing carbon emissions and carbon removal by 2050[24] has spurred net zero pledges worldwide.[25]

Notwithstanding the slow progress in mitigation efforts to date, economically and technologically feasible pathways to reduce GHG emissions consistent with the Paris temperature goals do exist.[26] A 2021 National Academy of Sciences study concluded, for

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[24] IPCC, *supra* note 19, at 12. The IPCC is the United Nations body responsible for assessing the science related to climate change. *See Intergovernmental Panel on Climate Change*, https://perma.cc/F8Q9-KTWR (last visited Jan. 16, 2022) (describing the IPCC's creation and purpose).

[25] *See* EMISSIONS GAP REPORT 2021, *supra* note 15, at 18 (calling net-zero emission pledges a development emerging from the Paris Agreement's goals); ENERGY & CLIMATE INTEL. UNIT, COUNTDOWN TO ZERO 1, 4 (2019) [hereinafter ECIU] ("'[N]et zero' is on the international agenda as an explicit indicator of whether a nation, region, city or business is committed to delivering the Paris Agreement."); Oliver Geden & Felix Schenuit, Unconventional Mitigation: Carbon Dioxide Removal as a New Approach in EU Climate Policy 9, 16 (2020) (SWP Research Paper No. 8) (stating that the IPCC's special report made it increasingly apparent that actors are now discussing and deciding on net-zero targets).

[26] *See* Mark Z. Jacobson et al., *Impacts of Green New Deal Energy Plans on Grid Stability, Costs, Jobs, Health, and Climate in 143 Countries*, 1 ONE EARTH 449, 449–50 (2019) ("[S]tudies among at least 11 independent research groups have found that transitioning to

example, that "[a] transition to a net-zero economy in the United States by midcentury is technologically feasible, with energy system costs as a share of U.S. gross domestic product that have been manageable over the past decade, but it is on the edge of feasibility."[27] Another study found that countries representing over 99 percent of CO_2 emissions could achieve 80 percent renewable energy by 2030 and 100 percent renewable energy by 2050 while generating millions of jobs, shrinking energy needs by more than half, and reducing energy, health, and climate costs.[28] As these assessments suggest, the challenges are primarily political in nature: societies have or are developing the technological capacity to drastically reduce emissions at a reasonable cost but must still put policies in place to facilitate the transition. Such policies include measures to accelerate the shift from fossil fuels to renewables, efficiency standards, investments in energy infrastructure, and support for

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100% renewable energy in one or all energy sectors, while keeping the electricity and/or heat grids stable at a reasonable cost, is possible."); AMOL PHADKE ET AL., 2035 REPORT 2 (2020) (illustrating technical and economic feasibility of achieving 90 percent carbon-free electricity in U.S. by 2035); ERIC LARSON ET AL., NET-ZERO AMERICA (2d ver. 2020); *see also* ECIU, *supra* note 25, at 6 (noting analyses indicating that net zero by 2050 is feasible).

[27] NAT'L ACADS. OF SCIS., ENG'G, & MED., ACCELERATING DECARBONIZATION OF THE U.S. ENERGY SYSTEM 12 (2021) [hereinafter NAS, ACCELERATING DECARBONIZATION].

[28] Jacobson et al., *supra* note 26, at 449.

emerging low-carbon technologies.[29] These technologies could include carbon capture and storage (CCS), which captures carbon emissions from fossil fuel combustion and industrial processes before their release but to date has had a limited role because of its relatively high costs.[30]

B. *Carbon Removal*

Net zero cannot be achieved through mitigation efforts alone. Some GHG emissions—such as emissions from aviation and shipping—will be very difficult to eliminate.[31] Residual GHG emissions will necessitate significant levels of carbon removal from the atmosphere.[32] An individual nation can achieve net zero either by removing carbon at a level equivalent to its residual emissions or by obtaining emission offsets that reflect

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[29] *See* NAS, ACCELERATING DECARBONIZATION, *supra* note 27, at 43–50 (detailing how deep decarbonization is technologically feasible if significant efforts are made); *see also* INT'L ENERGY AGENCY, ENERGY TECHNOLOGY PERSPECTIVES 2020, at 26 (2021) [hereinafter IEA, ENERGY TECH] (concluding that "[g]overnments have an outsized role to play in supporting transitions towards net-zero emissions").

[30] GLOBAL CCS INST., GLOBAL STATUS OF CCS 2019, at 12 (2019), https://perma.cc/CS8W-LR4K (PDF).

[31] *See* Steven J. Davis et al., *Net-Zero Emissions Energy Systems*, 360 SCIENCE eaas9793, at 1 (2018) (noting difficulty in eliminating carbon emissions from long-range transport and steel and cement production).

[32] SBTI, *supra* note 2, at 7.

emission reductions outside of its boundaries.[33] At the global scale, however, emission offsets are unavailable. Simply put, the less progress that the international community makes on mitigation, the more it will need to rely on carbon removal to make up the difference. Even with aggressive mitigation, proposed pathways for achieving net zero in the United States suggest that 10–20 percent of current GHG emissions would have to be offset by carbon removal.[34] To achieve net zero globally, global carbon removal levels similarly would have to expand on a "mindboggling" scale.[35]

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[33] *Id.* The Science Based Targets Initiative uses the term "offset" to refer either to "compensation measures," which involve the reduction of emissions outside of a company's value chain, or "neutralisation measures," which refer to either CCS or carbon removal. *Id.* at 7, 17.

[34] *See* NAS, ACCELERATING DECARBONIZATION, *supra* note 27, at 25 ("Most plans would offset between 10 and 20 percent of current emissions by negative CO2 emissions").

[35] Matthias Honegger & David Reiner, *The Political Economy of Negative Emissions Technologies: Consequences for International Policy Design*, 18 CLIMATE POL'Y 306, 308 (2018). *See* NAT'L ACADS. OF SCIS., ENG'G, & MED., NEGATIVE EMISSIONS TECHNOLOGIES AND RELIABLE SEQUESTRATION: A RESEARCH AGENDA 9 (2019) [hereinafter NAS, NEGATIVE EMISSIONS TECHNOLOGIES] (estimating need to remove 10–20 Gt of CO_2 per year globally).

Natural processes, including plant growth and carbon mineralization, remove carbon from the atmosphere.[36] By themselves, these gradual processes are insufficient to achieve net zero emissions. Various techniques—sometimes dubbed negative emission technologies—have been proposed to accelerate these processes or to engineer the capture of GHGs from the atmosphere.[37] Virtually all these technologies aim to remove CO_2 and thus are commonly referred to as carbon dioxide removal or carbon removal. Unlike mitigation, which reduces or captures emissions prior to release into the atmosphere, carbon removal takes place after CO_2 is released.[38] The various carbon removal techniques, which face diverse constraints on

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[36] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 28–31, 247 (stating that carbon is removed from the atmosphere through enhanced photosynthesis and forest regrowth, as well as by carbon mineralization that occurs naturally during the weathering of silicate materials).

[37] For a review of these technologies and their current technological readiness, see NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35; Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, 13 ENV'T. RSCH. LETTERS 063001 (2018); ROYAL SOC'Y, GREENHOUSE GAS REMOVAL 11 (2017). The term "greenhouse gas removal" is used interchangeably with "negative emissions technologies." *See, e.g., id.* at 13.

[38] *See* Minx et al., *supra* note 37, at 4, 13 (attempting to clarify the boundary between carbon dioxide removal and mitigation).

their potential large-scale deployment,[39] fall into two basic categories: nature-based techniques and engineered carbon removal.[40] Generally speaking, nature-based techniques are more mature but offer limited and less permanent carbon storage capacity, whereas engineered carbon removal technologies are less mature but have greater and more permanent carbon storage potential.[41]

The most prominent nature-based techniques are forest carbon management and soil carbon sequestration. Forest carbon management includes conversion of unforested land to forest—through afforestation and reforestation—and improved management of existing forests to increase carbon stocks.[42] These practices, which are already being implemented in

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[39] *See* IPCC, *supra* note 19, at 316, 394; NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 7-8 (listing difficulties various NETs face such as limited land availability, high cost, and unknown environmental impacts).

[40] *See* Minx et al., *supra* note 37, at 4 (stating that carbon dioxide removal methods "involve the ocean, land and technical systems, including such methods as iron fertilization, large-scale afforestation and direct capture of CO2 from the atmosphere using engineered chemical means").

[41] *See id.* at 12 (graphing the costs and benefits of carbon dioxide removal methods).

[42] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 89 (detailing forest carbon management techniques).

some places, offer relatively limited and potentially impermanent carbon storage.[43] Annual carbon storage capacity from forest carbon management is estimated at 0.25 Gt CO_2 in the United States and 2.5 Gt CO_2 globally, assuming deployment in a manner that avoids large adverse impacts.[44]

Soil carbon sequestration refers to land management practices that increase carbon content in the soil. This mature technique generates a co-benefit of improved soil productivity but faces limitations in permanence and scalability.[45] Annual carbon storage potential from improved cropland and grassland management is estimated at a modest 0.25 Gt CO_2 in the

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[43] *See* IPCC, *supra* note 19, at 343 (describing afforestation and reforestation as limited by "constraints related to land use" and having limited potential over time due to saturation of forests); Albert C. Lin, *Carbon Dioxide Removal after Paris*, 45 ECOLOGY L.Q. 533, 540–41 (2018) (stating that afforestation and reforestation offer only short-term carbon storage, reduce albedo, and have limited carbon storage potential). For a definition of afforestation and reforestation, as well as "forest management that enhances tree growth" and "prevention of degradation and deforestation," see G. Cornelis van Kooten, *Forest Carbon Offsets and Carbon Emissions Trading: Problems of Contracting*, 75 FOREST POL'Y & ECON. 83, 84 (2017).

[44] NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 6, 112, fig.3.1.

[45] *See* IPCC, *supra* note 19, at 345 (reviewing the literature on soil carbon sequestration and biochar); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 123 (detailing the co-benefits of soil carbon sequestration practices); NCI, ACCELERATING NET ZERO, *supra* note 2, at 3–4 (discussing soil carbon sequestration).

United States and 3 Gt CO_2 globally.[46] Soil carbon sequestration can be enhanced by amending soils with biochar—organic material heated in the absence of carbon. Estimates of biochar's potential to store carbon vary and may depend on biochar type, soil type, and environmental and management conditions.[47]

Given the relatively limited capacity of nature-based techniques to store carbon, significant levels of engineered carbon removal will be necessary to achieve Paris's goals.[48] Engineered carbon removal techniques incorporate substantial technological innovation and include bioenergy with carbon capture and storage (BECCS), direct air capture and storage (DACS), and enhanced weathering.[49] BECCS combines the combustion of biomass at power

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[46] NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 6, 112, fig.3.1.

[47] *See* IPCC, *supra* note 19, at 345 (evaluating research on soil carbon sequestration and biochar); Sabine Fuss et al., *Negative Emissions—Part 2: Costs, Potentials and Side Effects*, 13 ENV'T. RSCH. LETTERS 063002, at 26 (2018) (suggesting that "a lower range of 0.3 – 2.0 $GtCO_2$ yr^{-1} by 2050 seems plausible").

[48] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 8–9, 13 ("If the goals for climate and economic growth are to be achieved, negative emissions technologies will likely need to play a large role").

[49] *See* Matt Piotrowski & Claire Langley, Climate Advisers, Technological Carbon Removal: Recent Economic and Political Trends in the United States 6 (2019) (detailing carbon dioxide removal techniques); Ethan L. Elkind et al., Capturing Opportunity: Law and

stations to produce energy with the capture of CO_2 generated during combustion and its storage in geologic reservoirs.[50] Requiring significant amounts of land and water, BECCS has yet to achieve commercial deployment because of its high cost and lack of infrastructure.[51] Nonetheless, estimates suggest a potential for BECCS to store 3.5–5.2 Gt CO_2 globally each year by 2050.[52]

DACS projects would capture CO_2 from the air via chemical processes and store it in geologic reservoirs.[53] These facilities would require relatively little land, can be located flexibly, and offer potentially immense storage capacity.[54] The technology is currently the subject of several demonstration projects but is not ready for deployment.[55] DACS's energy

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Policy Solutions to Accelerate Engineered Carbon Removal in California 1 (2020) (stating that carbon dioxide removal techniques can include "bioengineered approaches or enhancement of natural carbon sinks" as well as "engineered options").

50 *See* NCI, ACCELERATING NET ZERO, *supra* note 2, at 4.

51 *See* IPCC, *supra* note 19, at 342 (stating that incentives for ramping up BECCS are weak and detailing the high costs of creating BECCS infrastructure); Lin, *supra* note 43, at 537–39 (stating that BECCS "is far from ready for large-scale deployment" in part because carbon capture and storage has not reached commercial scale due to its cost).

52 NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 7, 154.

53 IPCC, *supra* note 19, at 346.

54 *See id.*

55 GLOBAL CCS INST., GLOBAL STATUS OF CCS 2021, at 59 (2021), https://perma.cc/WL2R-2N8W (PDF).

requirements result in substantially higher overall costs than other carbon removal techniques, though further research and development could bring these costs down.[56]

Enhanced weathering involves spreading ground-up rocks on land or in the ocean to facilitate chemical reactions that absorb CO_2 from the atmosphere.[57] Potential limitations of enhanced weathering, which has been the subject of limited study, include cost,

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[56] *See* IPCC, *supra* note 19, at 346 (stating there are some optimistic outlooks that DACS may be brought to scale); NCI, ACCELERATING NET ZERO, *supra* note 2, at 4 (stating that basic science innovations are important factors in "expanding the scope of approaches to direct air capture"); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 232 (discussing the DACS research needed).

[57] *See* IPCC, *supra* note 19, at 345. Enhanced weathering is a subcategory of carbon mineralization, which encompasses various potential methods of storing CO_2 in carbonate minerals. *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 304 (explaining the costs and benefits of "combined mineral capture from air and solid storage"). Another subcategory, in situ carbon mineralization, is "a largely speculative" technique in which CO_2-bearing fluids would be circulated through underground rock formations. *Id.* at 249, 273 (defining and explaining the scientific process of in situ carbon mineralization).

environmental impacts, and scalability.[58] The practical storage capacity of enhanced weathering is uncertain in light of its technological immaturity.[59]

Achieving net zero goals, which will require substantial amounts of carbon removal, would only stabilize atmospheric GHG concentrations.[60] Drawing down excess CO_2 levels in the atmosphere will require even greater levels of carbon removal—i.e., net negative emissions.[61] But carbon removal's ability to compensate for inadequate mitigation is not

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[58] *See* IPCC, *supra* note 19, at 345 (listing the costs and "side effects" of enhanced weathering, which include the release of metals and increased pH in bodies of water); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 14 (explaining the high costs and underexplored technologies of carbon mineralization and direct air capture); Lin, *supra* note 43, at 541 (noting the "possible ecological consequences" and uncertainty "of enhanced weathering").

[59] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 6-7 (displaying the estimated cost, potential CO_2 removal, and limiting factors of different negative emission technologies).

[60] *See* IPCC, *supra* note 19, at 17 ("[Carbon dioxide removal] would be used to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak.").

[61] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 4 (explaining that scenarios for achieving 1.5°C require that "emissions do not stop declining at net zero—they ultimately become net negative"); IPCC, *supra* note 19, at 17 (describing the different effects of large scale application of carbon dioxide removal techniques).

boundless. As explained later, limitations of scale, efficacy, cost, and sustainability are associated with each carbon removal technique in varying degrees.[62]

C. *Net Zero*

Net zero is not only a global ambition but increasingly a target for governments and private actors. Net zero planning can guide carbon mitigation and removal and establish criteria for measuring performance, while allowing for adjustments as circumstances change and more information arises.[63]

Whether invoked by governments or private entities, net zero can take on different meanings. An entity may apply its net zero target to a specific sector or product.[64] Some targets encompass only those emissions arising within a jurisdiction's boundaries or a company's operations (commonly referred to as "Scope 1 emissions").[65] Some companies include—in addition to Scope 1 emissions—emissions relating to the company's use of grid-supplied energy ("Scope 2 emissions"), as well as emissions generated by the company's

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[62] *See infra* Part IV.B.2; *see also* M.J. MACE ET AL., GOVERNING LARGE-SCALE CARBON DIOXIDE REMOVAL: ARE WE READY? 14 (2018), https://perma.cc/9F6G-GMBV (PDF) (explaining that using various carbon removal techniques is necessary to reduce the impacts of their limitations and risks).

[63] *Cf.* Edward L. Rubin, *Law and Legislation in the Administrative State*, 89 COLUM. L. REV. 369, 413–15 (1989) (discussing strengths of goal-oriented legislation).

[64] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 22 (explaining that companies' net zero goals "do not necessarily apply to companies' full emissions").

[65] *Id.* at 9.

supply chain and the transport, use, and disposal of the company's products ("Scope 3 emissions").[66] Net zero targets also vary in terms of whether an entity intends to achieve its target on its own or by relying on carbon credits that reflect emissions reductions or carbon removal by other actors.[67] In light of the multiple ways of defining net zero, transparency is essential to understanding each target, holding entities accountable, and making meaningful progress in addressing climate change.[68]

1. National Net Zero Commitments

Government net zero commitments are consistent with, but not required by, the Paris Agreement. The agreement reflects a bottom-up approach to climate mitigation: rather than imposing a top-down mandate that parties reduce their GHG emissions, it allows each party

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[66] *Id.* at 9 tbl.1. *See* WORLD ECONOMIC FORUM, NET-ZERO CHALLENGE: THE SUPPLY CHAIN OPPORTUNITY 7 (2021) [hereinafter WEF] (explaining and illustrating the differences between Scope 1, 2 and 3). For governments, Scope 3 emissions include emissions outside a jurisdiction's boundaries that result from activities within those boundaries. *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 9 tbl.1 (illustrating the differences between subnational and corporate actors in regard to Scope 1, 2, and 3).

[67] *See* IEA, NET ZERO, *supra* note 1, at 34 (explaining that "some pledges allow GHG mitigation that occurs outside a country's borders to be counted towards the net zero target"); NCI, NAVIGATING THE NUANCES, *supra* note 6, at 47 (exploring concerns raised by use of carbon offsets).

[68] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 58 ("Transparency can facilitate accountability and positive pressure for target quality.").

to declare its own "Nationally Determined Contribution" (NDC).[69] National net zero targets are consistent with the Paris approach in that they involve pledges, voluntarily made and individually determined, by each nation of its contribution to addressing climate change.[70] To avoid shifting responsibility to other nations, a national net zero target would balance GHG emissions from sources within that country with GHGs removed by sinks within that country.[71]

Although national and subnational governments' net-zero targets may be enshrined in legislation, most targets so far have taken the form of nonbinding policy goals.[72] The

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[69] Paris Agreement art. 3, *supra* note 18.

[70] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 8 (noting that several countries have incorporated net-zero targets into their NDCs under the Paris Agreement).

[71] *See id.* at 6 (describing the differences between a country's net-zero emissions levels with and without international transfers of GHG mitigation).

[72] *See* IEA, NET ZERO, *supra* note 1, at 32 (explaining that out of the 44 countries with net-zero emission pledges, "ten countries have made meeting their net zero target a legal obligation"); Levin et al., *Designing and Communicating*, *supra* note 4, at 2, 7–8 (listing the countries that have made net-zero emissions pledges through either law, strategy, policy, or a collective commitment); ECIU, *supra* note 25, at 11 (counting countries, states, regions, cities, and companies that have made net-zero emission commitments). National net zero commitments are tracked at https://eciu.net/netzerotracker.

European Union and Japan have committed to achieve net zero GHGs by 2050.[73] China has pledged to become carbon neutral by 2060.[74] The United States has set a goal of achieving net zero emissions by 2050,[75] and its 2021 "Long Term Strategy" describes necessary

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[73] *See* European Commission Press Release IP/20/335, Committing to Climate-Neutrality By 2050: Commission Proposes European Climate Law and Consults on The European Climate Pact (Mar. 4, 2020), https://perma.cc/SPZ5-2JUF (noting EU's existing political commitment and describing proposed European Climate Law); Simon Denyer & Akiko Kashiwagi, *Japan, World's Third Largest Economy, Vows to Become Carbon Neutral by 2050*, WASH. POST (Oct. 26, 2020), https://perma.cc/5R7V-CGBF.

[74] *See* Somini Sengupta, *China, in Pointed Message to U.S., Tightens Its Climate Targets*, N.Y. TIMES (Sept. 22, 2020), https://perma.cc/ZYR9-AW8Y (last updated Nov. 13, 2020) ("President Xi Jinping of China pledged on Tuesday that his country would adopt much stronger climate targets and achieve what he called 'carbon neutrality before 2060.'").

[75] *See* Exec. Order No. 14,008, § 201, 86 Fed. Reg. 7619 (Feb. 1, 2021) (describing the United States' "government-wide approach to the climate crisis").

technological transformations as well as possible pathways for achieving that goal.[76] States and cities representing 35 percent of the U.S. population have adopted net zero targets.[77]

Thus far, net zero declarations have included few concrete details or credible plans on how nations will achieve their targets or counter residual GHG emissions.[78] Some countries

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[76] *See* U.S. Dep't of State & Exec. Off. of the President, The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050, at 5–6, 17–24 (2021).

[77] *See* Full Committee Hearing to Examine Development and Deployment of Large-Scale Carbon Dioxide Management Technologies Before the S. Comm. on Energy & Nat. Res., 116th Cong. 4 (2020) (statement of Ernest J. Moniz, President and CEO of Energy Futures Initiative, Inc.), https://perma.cc/XDN4-25FF.

[78] *See* IEA, NET ZERO, *supra* note 1, at 34 ("few net zero pledges are supported by detailed policies and firm routes to implementation"); Geden & Schenuit, *supra* note 25, at 21. For example, Australia's plan to achieve net zero by 2050 has been criticized as "mostly magical thinking" because of its heavy reliance on largely untested technologies and on hydrogen made from fossil fuels. Damien Cave, *Australia Pledges "Net Zero" Emissions by 2050. Its Plan Makes That Hard to Believe*, N.Y. TIMES (Oct. 26, 2021), https://perma.cc/W2L3-NTG7 (last updated Nov. 3, 2021) (describing the Australian government's process of finalizing its emissions plan and technological approach to reaching its goals).

plan to rely on carbon offsets in order to achieve net zero.[79] Saudi Arabia, for example, intends to offset continued oil production with carbon removal.[80] Many countries with net zero targets have simply pledged to balance emissions and removals rather than establishing distinct targets for GHG emissions reductions and GHG removals.[81] Among the few with distinct targets are Finland, which has announced a net zero target for 2035 and set a separate sub-target for CO_2 removal,[82] and Sweden, whose 2045 net zero goal includes a separate target of reducing GHG emissions by 85 percent.[83]

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79 *See* IEA, ENERGY TECH, *supra* note 29, at 362 (listing Sweden, Norway, Chile, and Switzerland as countries planning to use "international carbon offsets to meet their targets").

80 *See* Sara Schonhardt, *Saudi Arabia's Climate Plan Relies on More Oil*, CLIMATEWIRE (Nov. 8, 2021, 6:30 AM), https://perma.cc/88KZ-Q78W (explaining Saudi Arabia's plan to implement carbon capture technologies so that it can continue to produce oil).

81 *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 22–23 app. B (listing countries and comparing their coverage of GHGs, domestic sectors, and target years).

82 *See* Geden & Schenuit, *supra* note 25, at 22 (explaining Finland's "net-zero target for 2035 as an intermediate step towards net negative emissions").

83 *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 15 ("Sweden has also set a target for emissions from activities within the country in 2045 to be at least 85 percent below 1990 levels."). The country is considering carbon removal or international offsets to make up for the remaining 15 percent of its emissions. *See* Felix Schenuit et al., *Carbon*

Some nations have begun to identify the carbon removal techniques they intend to rely on to achieve net zero. Several EU nations plan to rely primarily on land-based carbon removal (forestry).[84] France intends to rely on BECCS to remove ten megatons of carbon per year by 2050.[85] China anticipates substantial deployment of nature-based carbon removal, including tree planting and wetlands restoration.[86] However, it will likely need significant

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Dioxide Removal Policy in the Making: Assessing Developments in 9 OECD Cases, 3 FRONTIERS IN CLIMATE, March 2021, at 7 [hereinafter *Carbon Dioxide Removal*], https://perma.cc/2T65-EKAG (PDF) (explaining Sweden's target structure for emission reduction).

[84] *See* Geden & Schenuit, *supra* note 25, at 22–23 (listing Finland and Sweden as examples of such countries).

[85] *See id.* at 22 (stating that France is the only EU member with "a technological CO_2 removal method").

[86] *See Beijing's Plan to Reach Carbon-Neutral Goal Raises Questions*, CLIMATEWIRE (Oct. 13, 2020), [hereinafter *Beijing's Plan*] https://perma.cc/JJ73-9HSY (describing Beijing's projects to plant "billions of trees" and to restore "hundreds of thousands of hectares of wetlands"); Ranping Song, *4 Questions About China's New Climate Commitments*, WORLD RESOURCES INSTITUTE (Sept. 30, 2020), https://perma.cc/JZ55-KQPJ (arguing that "China will need to fully unleash the potential of afforestation, wetland restoration and other natural-based solutions").

levels of CCS[87] and engineered carbon removal as well.[88] The United States has pointed to both nature-based and engineered carbon removal techniques as "critical" for achieving net zero.[89]

Although the United States has yet to adopt a detailed net zero strategy, expert analyses suggest that it would likely include dramatically expanding renewable energy,

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[87] CCS, typically classified as a form of carbon mitigation, shares characteristics of both mitigation and carbon removal. *See* EVE TAMME, CARBON REMOVAL WITH CCS TECHNOLOGIES 2 (2021), https://perma.cc/7U5A-WSHS (PDF) ("Carbon capture and storage (CCS) offers climate change mitigation solutions by removing carbon dioxide (CO2) from the point sources, or the atmosphere, and storing it underground."). Unlike carbon removal, CCS captures carbon *before* it is released into the atmosphere. Emily Rhode, *Carbon Capture and Storage (CCS) Pros and Cons*, TREEHUGGER, https://perma.cc/5U5Y-2Z86 (last updated Aug. 13, 2021) (describing the benefits of CCS as being able to eliminate emissions at the source). However, CCS differs from conventional mitigation in that it assumes the generation of GHGs and stores those gases geologically. *See id.* (stating the biggest advantage of CCS is its permanent store of gases underground in geological formations). In this regard, CCS resembles engineered carbon removal—and indeed involves the same geological storage processes as BECCS and DACS. *See* EVE TAMME, CARBON REMOVAL WITH CCS TECHNOLOGIES 5 (2021), https://perma.cc/7U5A-WSHS (PDF).

[88] *See Beijing's Plan*, *supra* note 86 (arguing that "it's unlikely that China . . . can get to net zero without some sort of carbon dioxide removal").

[89] Long Term-Strategy, *supra* note 76, at 46.

electrifying transportation and buildings, replacing fossil fuels with hydrogen and other zero-carbon fuels, managing forests and farmlands with a focus on carbon, reducing emissions of non-CO_2 GHGs, and increasing energy and materials efficiency.[90] These analyses generally acknowledge the need to deploy carbon removal technologies to offset residual emissions.[91] One study by Princeton University researchers projects a need for 0.9–

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[90] *See* NAS, ACCELERATING DECARBONIZATION, *supra* note 27, at 30–31, 48–49 (listing recommendations to Congress); SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK, ZERO CARBON ACTION PLAN 2 (2020) [hereinafter ZCAP]

> The key components required for the new green-growth model presented in this document include: (1) Rapid upscaling of renewable energy; (2) Electrification; (3) Transition to hydrogen, advanced biofuels, and other clean fuels; (4) Sustainable Forest and agricultural lands; (5) Reduced material wastes through Sustainable Materials Management; (6) Rejuvenation of the industrial heartland of America with a special focus on the Appalachian Region and the Midwest; (7) Government-backed financing, investments, and regulatory support; and (8) a national Research, Development, Demonstration and Deployment (RDD&D) strategy.

LARSON ET AL., *supra* note 26, at 9–10 (listing the "six pillars [that] are needed to support the transition to net-zero"); James H. Williams et al., *Carbon-Neutral Pathways for the United States*, AGU ADVANCES, Nov. 12, 2021, at 2, https://perma.cc/TNJ6-HJVR.

[91] *See* LARSON ET AL., *supra* note 26, at 10, 257 (identifying carbon capture and storage and enhanced land sinks as two of six key pillars for achieving net zero); Williams, *supra* note 90, at 17.

1.7 Gt/CO_2 storage per year by 2050 involving thousands of injection wells.[92] Another study nonetheless warns that "it is highly uneconomic to achieve carbon neutrality through a strategy of continuing high levels of gross CO_2 emissions from burning fossil fuels that are offset by [carbon removal]."[93] Achieving net zero in the United States can happen at a modest cost but will require dramatic changes in infrastructure and technologies.[94]

2. Corporate Net Zero Commitments

Net zero commitments by private actors have also grown in number and importance. Though these commitments are voluntary and legally unenforceable, their achievement could make a sizeable contribution to addressing climate change.[95]

Corporations that have made net zero pledges represent a wide range of sectors. Taken together, these companies total over $12 trillion in revenue and nearly 25 million

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92 LARSON ET AL., *supra* note 26, at 10 (describing the necessary methods to capture and store enough carbon). The carbon would be captured not only from industrial facilities and gas-fired power plants, but also biomass-fired power plants and direct air capture facilities. *Id.* at 231 (discussing the different methods of capturing carbon).

93 ZCAP, *supra* note 90, at 45.

94 *See* Williams, *supra* note 90, at 7–10 (estimating such costs as less than one percent of GDP).

95 *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 20 (noting that "companies pursuing net-zero emissions have a footprint greater than 3.5 gigatonnes of GHG annual emissions, which is more than India's annual emissions").

employees, and have a carbon footprint exceeding 3.5 Gt GHGs.[96] Corporate net zero pledges vary widely in terms of their timelines, scope of activities covered, and plans for implementation.[97] Many pledges focus on the year 2050, but some specify earlier or later dates.[98] Some pledges cover emissions associated with a company's operations and exclude emissions associated with its supply chain or use of its products.[99] Moreover, some corporate

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[96] *See id.* 19–20 (describing companies' massive impact on the environment); Maitane Sardon, *Total Pledges Net-Zero Emissions by 2050*, WALL ST. J. (May 5, 2020) https://perma.cc/U4KF-TCCY (analyzing pledges made by European oil companies). For a list detailing many of these corporate pledges, see *Carbon Removal Corporate Action Tracker*, INST. FOR CARBON REMOVAL L. & POL'Y (May 7, 2020), https://perma.cc/LZ5H-2L58.

[97] *See* SBTI, *supra* note 2, at 5, 14–15 (providing a science-based net-zero standard for companies and financial institutions); NCI, NAVIGATING THE NUANCES, *supra* note 6, at 25 fig.6 (presenting overview of different net-zero approaches).

[98] *See* NCI, ACCELERATING NET-ZERO TARGET SETTING, *supra* note 2, at 15 (providing examples of companies with different target dates such as 2020, 2030, 2050, and 2100); IEA, ENERGY TECH, *supra* note 29, at 365 box 7.2 (describing corporate net-zero emission targets).

[99] *See, e.g.,* Sardon, *supra* note 96 (discussing net zero pledges by major European oil companies).

strategies rely on the purchase of offsets representing emissions reductions by a third party, potentially obscuring a company's own failure to decarbonize.[100]

A handful of companies have offered some detail on how they expect to reach net zero, with many intending to rely significantly on CCS or nature-based carbon removal, and a few beginning to invest in engineered carbon removal.[101] For example, Apple aims to achieve carbon neutrality by 2030 by reducing its emissions by 75 percent and "investing in forests and other nature-based solutions around the world to remove carbon from the

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[100] *See* SBTI, *supra* note 2, at 24 ("To ensure that [financial institutions'] net-zero targets lead to a state that is compatible with reaching net-zero emissions at the global level, all operational and financing activities at a parent-level, over which FIs have influence, should be addressed."); NCI, NAVIGATING THE NUANCES, *supra* note 6, at 27, 47 (warning against the limitations of claiming carbon neutrality by offsetting).

[101] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 52 (noting that offset credits from forestry-related projects are "by far the most popular type of offset credit on the voluntary market"); Brad Plumer & Christopher Flavelle, *Businesses Aim to Pull Greenhouse Gases from the Air. It's a Gamble*, N.Y. TIMES (Jan. 18, 2021), https://perma.cc/9P4J-U2FS (last updated Oct. 10, 2021) (describing the widespread corporate interest in carbon removal and discussing some of its risks).

atmosphere."[102] Similarly, Amazon plans to rely on reforestation projects to achieve net zero by 2040.[103] Microsoft promises to become carbon negative by 2030 and remove all the carbon it has ever emitted by 2050, and it has joined the oil industry's Northern Lights initiative, a project to capture 100 million tons of industrial carbon emissions and to store it in subsea reservoirs off the coast of Norway.[104] The company also has expressed interest in

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[102] Press Release, Apple, Apple Commits to be 100 Percent Carbon Neutral for Its Supply Chain and Products by 2030 (July 21, 2020), https://perma.cc/P5AQ-H8P7; *see also* Somini Sengupta & Veronica Penney, *Big Tech Has a Big Climate Problem. Now, It's Being Forced to Clean Up*, N.Y. TIMES (July 21, 2020), https://perma.cc/ASW7-PE6R (describing Apple's pledge and the critiques from climate advocates).

[103] *See* Sengupta & Penney, *supra* note 102 ("Amazon announced last September its bid to be carbon-neutral by 2040.").

[104] *See* Stanley Reed, *Europe's Big Oil Companies Are Turning Electric*, N.Y. TIMES (Aug. 17, 2020), https://perma.cc/2LEA-UBQA (discussing the oil industry's turn towards cleaner energy); Lorence Heikell, *Northern Lights Is Innovating for the Future of Carbon Transport and Storage*, MICROSOFT (Oct. 14, 2020), https://perma.cc/B629-GSX3 (announcing the partnership between Microsoft and Northern Lights); Lucas Joppa et al., Comment, *Microsoft's Million-Tonne CO_2-Removal Purchase—Lessons for Net Zero*, 597 NATURE 629 (2021), https://perma.cc/6R6L-B2C5 (PDF) (discussing Microsoft's commitment to reducing its emissions by paying for 1.3 million tons of CO_2 to be removed from the atmosphere).

afforestation, reforestation, soil carbon sequestration, BECCS, and DACS.[105] And United Airlines, as part of its commitment to achieve carbon neutrality by 2050, announced a multimillion-dollar investment to support DACS technology development.[106]

Utility and energy companies' net zero pledges are of particular interest because of their carbon-intensive operations. To reach net zero by 2050, the Southern Company, an electric utility, plans to rely on CCS, DACS, and afforestation.[107] Duke Energy and Entergy likewise promise to achieve net zero by 2050 through a combination of existing techniques

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[105] *See* David Roberts, *Microsoft's Astonishing Climate Change Goals, Explained*, VOX, (Jul. 30, 2020, 10:10 AM), https://perma.cc/VL93-8AND (describing the company as "setting new standards" and discussing the breadth of its commitment).

[106] *See United Makes Bold Environmental Commitment Unmatched by Any Airline; Pledges 100% Green by Reducing Greenhouse Gas Emissions 100% by 2050*, CISION (Dec. 10, 2020), https://perma.cc/S6CL-ZGDT ("United becomes the first airline in the world to announce a commitment to invest in Direct Air Capture technology.").

[107] *See* Kristi E. Swartz, *Southern Company Commits to Net-Zero CO_2 Emissions by 2050*, ENERGYWIRE (May 28, 2020), https://perma.cc/WT2L-HLCT ("The company also is interested in so-called direct air capture, which removes carbon dioxide from the atmosphere, and afforestation, which adds trees to large areas where they did not previously grow.").

and new technologies.[108] Notwithstanding such pledges, a consultant's report found "significant gaps between [utilities'] decarbonization targets and the scheduled fossil-fuel plant retirements, renewable additions, and flexibility requirements needed" to achieve net zero.[109]

Even oil companies have begun to jump on the net zero bandwagon. Several European-based oil companies have made net zero pledges and initiated a shift in their business models away from fossil fuels.[110] Shell's net zero pledge relies on "storing away

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[108] *See* Edward Klump, *Entergy Rolls out 2050 Net-Zero Plan*, ENERGYWIRE (Sept. 25, 2020), https://perma.cc/DZ4N-E8MY (explaining Entergy's plan to invest in renewables and explore new technologies such as battery storage and carbon capture); *Duke Energy Aims to Achieve Net-Zero Carbon Emissions by 2050*, DUKE ENERGY (Sept. 17, 2019), https://perma.cc/GDJ7-62JS (describing Duke Energy's plan to reduce carbon emissions and invest in technology research).

[109] Stanley Porter et al., Utility Decarbonization Strategies: Renew, Reshape, and Refuel to Zero, DELOITTE (Sept. 21, 2020), https://perma.cc/8XNS-XM3T.

[110] *See* Nicholas Kusnetz, *Two U.S. Oil Companies Join Their European Counterparts in Making Net Zero Pledges*, INSIDE CLIMATE NEWS (Nov. 12, 2020), https://perma.cc/7LQZ-LQX4 (describing Occidental Petroleum and ConocoPhillips' net-zero pledges as the first from American oil companies but different from the pledges made by European oil companies). Exemplifying the more limited approach of U.S. oil majors, Chevron has expressed an

emissions that cannot be avoided, either through nature or using the technology that already exists to capture and store away CO_2."[111] BP's strategy to achieve net zero by 2050 includes "building scale in renewables and bioenergy [and] seeking early positions in hydrogen and

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"aspiration" to achieve net zero emissions—excluding Scope 3 emissions—by 2050. CHEVRON, CLIMATE CHANGE RESILIENCE: ADVANCING A LOWER CARBON FUTURE 2, 38 (2021), https://perma.cc/Y8HH-XUTU (PDF).

[111] *A Net-Zero Emissions Energy Business*, SHELL (Apr. 16, 2020), https://perma.cc/GVH7-SPEM. Shell has announced a short-term carbon reduction target, as well as an intent to set future targets annually. *See* DELOITTE, THE 2030 DECARBONIZATION CHALLENGE: THE PATH TO THE FUTURE OF ENERGY 15 (2020), https://perma.cc/4574-W85G (PDF) ("[Shell] recently announced a short-term target of reducing its net carbon footprint by 3% to 4% by the end of 2022, along with its intention to set targets annually, with each year's target covering either a three or five-year period.").

CCUS."[112] BP's strategy does not explicitly mention carbon removal, but the company likely will have to depend on CCS and nature-based carbon removal to achieve net zero.[113]

Most corporate pledges have not been accompanied by the disclosure of detailed strategies for achieving net zero.[114] Granted, possible pathways to net zero are riddled with uncertainty, and companies need time to figure out how to accomplish their pledges. Skeptics nonetheless worry that corporate net zero pledges may constitute little more than greenwashing.[115] For these pledges to have a meaningful impact, they must be subject to

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[112] *Our Strategy*, B.P., https://perma.cc/3839-C6X2 (last visited Jun. 18, 2021); Steven Mufson, *BP Built Its Business on Oil and Gas. Now Climate Change Is Taking It Apart*, WASH. POST (Aug. 4, 2020), https://perma.cc/HT6L-YBR4 (describing BP's "increase in spending on low-carbon energy").

[113] *See* Matt McGrath, *Climate Change: Study Pours Cold Water on Oil Company Net Zero Claims*, BBC NEWS (May 12, 2020), https://perma.cc/XBH2-EP52 ("All of the plans . . . are, to some degree, dependent on carbon capture and storage (CCS) technology and nature-based solutions such as planting trees.").

[114] *See* David Iaconangelo, *"The Math Doesn't Yet Add Up." Net-Zero Plans Fall Short*, ENERGYWIRE (Sept. 24, 2020, 6:21 AM), https://perma.cc/9BSZ-YY4C ("Many of the largest companies in the United States, including major energy firms, are not seriously planning to reduce carbon dioxide emissions or lack sufficiently detailed net-zero road maps[.]").

[115] *See* Roberts, *supra* note 105 (describing climate advocates' hesitation to trust corporate commitments).

careful scrutiny, and the companies that make them must be held accountable for failing to fulfill them.

II. ARE NET ZERO PLEDGES LIKELY TO MATTER?

Private net zero commitments are voluntary. Governmental net zero commitments are largely nonbinding, and even those that have been incorporated into law may not be enforceable.[116] Whether binding or not, net zero commitments may turn out to be little more than political and economic posturing unless backed by concrete plans and efforts. By setting goals without specifying how to achieve them, governments and private actors may duck difficult choices and costly actions.[117] In light of their potential limitations, will net zero commitments matter?

Public and private actors' motivations for making net zero pledges, examined below, shed light on this critical question. Although net zero pledges may constitute a blend of greenwashing and sincere commitments to addressing climate change, identifying mechanisms to hold actors accountable for their pledges will be essential.

A. *Motivations for Private Pledges*

Private entities' net zero targets exemplify private environmental governance—"actions taken by non-governmental entities that are designed to achieve

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116 *See* Rubin, *supra* note 63, at 415 (suggesting that courts generally are "designed to adjudicate claims of right, not achieve broad social policy results").

117 *See* David Schoenbrod, *Goals Statutes or Rules Statutes: The Case of the Clean Air Act*, 30 UCLA L. REV. 740, 747–48 (1983) (discussing how Congress' setting of ambitious goals in Clean Air Act allowed it to evade difficult policy questions).

traditionally governmental ends."[118] Companies may apply private environmental standards not only to themselves but also to suppliers, borrowers, and other entities with which they interact, sometimes reaching into different sectors and across national borders.[119] Investment manager BlackRock Inc., for example, could influence hundreds of other companies through its pledge to require companies it invests in to develop plans to achieve net zero by 2050.[120] Major lenders such as Citigroup, Morgan Stanley, JPMorgan Chase, Bank of America, Barclays, and HSBC have made similar pledges with respect to companies

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[118] Michael P. Vandenbergh, *Private Environmental Governance*, 99 CORNELL L. REV. 129, 146 (2013) [hereinafter Vandenbergh, *Private*].

[119] See *id.* at 156–58 (explaining supply chain contracting and providing examples).

[120] *See* Avery Ellfeldt, *BlackRock Puts Muscle Behind Push for Net Zero*, CLIMATEWIRE (Feb. 19, 2021, 6:42 AM), https://perma.cc/Q85R-VR3K (reporting on firm's threat to vote against company directors who fail to address company contributions to climate change).

that borrow from them.[121] Net zero pledges that include Scope 3 emissions, such as pledges made by Unilever and GE, similarly extend beyond narrowly defined corporate boundaries.[122]

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[121] *See* Avery Ellfeldt, *Citi Goes Net Zero. Who's Next?*, CLIMATEWIRE (Mar. 2, 2021), https://perma.cc/LA2W-GTSM (describing Citi's pledge to "eliminate planet-warming emissions associated with their financing activities" by 2050); Avery Ellfeldt, *Bank of America Pledges to Hit Net Zero by 2050*, CLIMATEWIRE (Feb. 12, 2021), https://perma.cc/KZK8-VUHH (listing Bank of America, JPMorgan Chase, and Morgan Stanley as banks committed to aligning their businesses with the Paris Agreement); Maitane Sardom, *Barclays Pledges Net Zero Emissions by 2050*, WALL ST. J. (Mar. 30, 2020), https://perma.cc/5CGC-FGEH (describing the pledges made by "Europe's largest money manager"); Alastair Marsh, *HSBC Shareholders Ask Bank To Cut Fossil-Fuel Lending Exposure*, CLIMATEWIRE (Jan. 11, 2021).

[122] *See* UNILEVER, CLIMATE TRANSITION ACTION PLAN 2 (2021), https://perma.cc/2AUG-SJRL (PDF) ("[Unilever's] target covers upstream Scope 3 emissions, Scope 1 & 2 emissions and mandatory downstream Scope 3 emissions."); Ryan Beene, *GE Sets 2050 Goal of Zero Emissions from Jet Engines, Gas Power,* BLOOMBERG GREEN (July 12, 2021, 9:00 AM), https://perma.cc/4QDW-YQP6 (explaining GE's dedication to address Scope 3 emissions); Emily Pontecorvo, *How to Make a Net-Zero Pledge That Actually Means Something*, GRIST (Sept. 22, 2020), https://perma.cc/PE4B-WYNL ("Scope 3 emissions make up the vast majority of most companies' carbon footprints, so it's essential that they are included in net-zero targets.").

Private environmental governance may be motivated by "a mixture of efficiency, resource supply, competition, and reputational goals that can all be squared neatly with profit maximization, along with altruistic preferences or norms."[123] Net zero commitments specifically can yield more energy-efficient operations, boost employee morale, burnish a company's reputation, and respond to pressure from customers, investors, and lenders.[124] These commitments also can express corporate values and improve a company's strategic position in anticipation of future developments.[125]

Some steps toward net zero, including energy efficiency measures and targeted investing, are win-win opportunities that can simultaneously increase profits and decrease carbon emissions.[126] These opportunities are substantial: an estimated 40 percent of GHG

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123 Vandenbergh, *Private*, *supra* note 118, at 180.

124 *See* MICHAEL P. VANDENBERGH & JONATHAN M. GILLIGAN, BEYOND POLITICS: THE PRIVATE GOVERNANCE RESPONSE TO CLIMATE CHANGE 138–49 (2017) (explaining how climate issues become a priority to individuals and corporations as well as the benefits of making climate concerns a priority).

125 *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 20 (explaining that some corporations value "sustainability in their corporate identity and as a selling point to consumers").

126 *See* Michael P. Vandenbergh, *Motivating Private Climate Governance: The Role of the Efficiency Gap*, 71 ARK. L. REV. 349, 353–54 (2018) [hereinafter Vandenbergh, *Motivating*]

emissions in key supply chains could be eliminated through measures that would save money or come at very low cost.[127] With respect to efficiency measures, private environmental governance can "provid[e] information about the efficiency opportunity, overcom[e] behavioral failures, better align[] incentives between principals and agents, or otherwise overcom[e] barriers to actions that are in the target's interest."[128] Relatedly, investing in companies that are implementing net zero strategies can benefit investors' bottom line by focusing on companies best positioned for the long term.[129]

("If many situations exist in which corporations and households can profit by reducing energy use, private initiatives that target corporations and households should not need the coercive power or resources of government to induce them to act . . . ."); GROUP OF 30, MAINSTREAMING THE TRANSITION TO A NET-ZERO ECONOMY 38 (2021), https://perma.cc/9RUN-QDTC (PDF) ("There is already evidence that by investing in 'greener' companies, investors can reap significant financial rewards.").

127 *See* WEF, *supra* note 66, at 17 (stating that about "40% of all emissions could be eliminated with measures that either yield savings . . . or come at abatement costs below €10 per ton of CO_2e").

128 Vandenbergh, *Motivating*, *supra* note 126, at 354.

129 *See* GROUP OF 30, *supra* note 126, at 40 ("A company that significantly lags behind its peers in reducing its emissions is more likely to lose market share as carbon prices increase than a company that is just as high carbon as its competitors.").

Achieving net zero will not always involve win-win situations.[130] When additional costs are involved, a company that adopts a net zero target presumably will have motivations other than direct cost savings.[131] Perhaps the reputational benefits from a net zero target will outweigh any sales lost due to higher costs.[132] Overall sales might increase if consumers are willing to pay more for low-carbon goods.[133] Although evidence on consumer willingness

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[130] *See* Desmond Butler & Steven Mufson, *Can the Market Save the Planet? FedEx Is the Latest Brand-Name Firm to Say It's Trying*, WASH. POST (Mar. 5, 2021, 7:00 AM), https://perma.cc/RK3Y-LTE7 (quoting U.C.S.D. professor David Victor) ("Net zero does not mean efficiency; it means complete transformation, and that's the challenge.").

[131] *See id.*

[132] *See id.*

[133] *See* WEF, *supra* note 66, at 21 ("[S]urvey-based studies indicate that more than 50% of consumers are willing to pay more for sustainable products."); VANDENBERGH & GILLIGAN, *supra* note 124, at 142 (noting studies finding willingness to pay a small premium in some cases but concluding that "overall consumer demand for low-carbon goods . . . is not overwhelming"). Price increases for end-consumers sometimes can be kept to a minimum. WEF, *supra* note 66, at 21 (estimating 1–4 percent rise in consumer prices in the medium term as a result of accounting for supply chain emissions).

to pay a premium for more sustainably produced goods and services is mixed,[134] a company may derive reputational benefits among corporate customers, lenders, investors, and employees even if sales do not increase.[135] Admittedly, such benefits can be difficult to measure, and they may depend more on the perception that a company is reducing emissions than its actual conduct.[136]

Some companies may set a net zero target in anticipation of future regulation or future markets. Shortly after President Biden's inauguration, GM announced that it would sell only electric vehicles by 2035 and achieve carbon neutrality by 2040.[137] The move apparently was

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[134] *See* Sarah E. Light & Eric W. Orts, *Parallels in Public and Private Environmental Governance*, 5 MICH. J. ENV'T. & ADMIN. L. 1, 69 n.304 (2015) ("Most studies thus far have focused on consumer demand as the primary motivating factor, but studies point to conflicting results.").

[135] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 142–43 (discussing corporate investments in building and maintaining reputation and evidence that corporate actions on climate change affect reputation).

[136] *See id.* at 142 ("The most important corporate motivations may arise less from corporate concerns about direct consumer purchasing behavior . . . than from more indirect brand reputation concerns.").

[137] *See* Neal E. Boudette & Coral Davenport, *G.M. Will Sell Only Zero-Emission Vehicles by 2035*, N.Y. TIMES (Jan. 28, 2021), https://perma.cc/F2A9-FYMK

made in response to political developments and a growing belief that electric cars will soon dominate the market for new automobiles.[138] Similarly, Shell's pledge to achieve net zero by 2050, inclusive of emissions associated with its products, reflects the company's assessment that focusing on "markets where demand for cleaner products and services is strongest" will "deliver[] more predictable cash flows and generat[e] higher returns."[139] Furthermore, net zero commitments by 35 U.S. utilities appear to reflect growing confidence in hydrogen as a fuel source and other potential technological advances.[140] Whether companies will take concrete actions to back up such pronouncements depends not only on their good faith but also on their willingness to make decisions based on long-term projections.

Companies often frame net zero targets in terms of doing the right thing. For example, BP's chairman declared, "[a]iming for net zero is not only the right thing for BP, it is the right

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(last updated Oct. 1, 2021) ("Leaders could point to G.M.'s decision as evidence that even big businesses have decided it is time . . . to transition away from fossil fuels that have powered the global economy for more than a century.").

[138] *See id.* (stating that electric cars are the "fastest-growing segment of the auto industry").

[139] Press Release, Shell, Shell Accelerates Drive for Net-Zero Emissions with Customer-First Strategy (Feb. 11, 2021), https://perma.cc/HC57-5G5M.

[140] *See* John Fialka, *How 35 Utilities Plan to Hit Net Zero*, E&E NEWS (Feb. 25, 2021), https://perma.cc/Q4DX-7P6H ("The leading innovation appears to be 'green' hydrogen, an energy carrier that can be produced with little or no CO2 emissions.").

thing for our shareholders and for society more broadly."[141] Nestle's CEO similarly wrote: "[a]s a good steward of the planet, Nestlé feels a moral obligation to make these changes and believes that the work we are doing is critical to the survival of supply chains and our business."[142] And Walmart's President and CEO announced, "[w]e want to go beyond sustainability to become a regenerative company dedicated to placing nature and humanity at the center of our business practices."[143] Such pronouncements warrant healthy skepticism. They nonetheless offer a reminder that factors other than profit may motivate corporate decision making.[144]

Notwithstanding a range of possible motivations, net zero targets undeniably pose a danger of greenwashing. In general, voluntary environmental programs in the United States

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[141] Press Release, B.P., BP Sets Ambition for Net Zero by 2050, Fundamentally Changing Organisation to Deliver (Feb. 12, 2020), https://perma.cc/T8KC-DGSJ.

[142] Mark Schneider, *Nestle CEO: Climate Change Laggards Put the Planet—and Their Businesses—at Risk*, FORTUNE (Dec. 2, 2020, 1:30 AM), https://perma.cc/C726-HXPJ.

[143] Doug McMillon, *Walmart's Regenerative Approach: Going Beyond Sustainability*, WALMART (Sept. 21, 2020), https://perma.cc/KAG8-AA25.

[144] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 151–52 (suggesting that corporate decision makers have flexibility to pursue goals in addition to pure profit).

have yielded limited environmental improvements.[145] The popularity of net zero targets and the lack of detail behind many of them suggest a serious risk of greenwashing.[146] Excluding Scope 3 emissions from net zero targets can allow companies to claim carbon neutrality while maintaining carbon-intensive business models.[147] The fact that many net zero targets are decades away raises further doubts: in the year 2050, will anyone notice or sanction an entity's failure to achieve a target set in 2022? Net zero targets might represent no more than empty promises that help companies deflect criticism and forestall regulation.[148] Although the relatively weak threat of GHG regulation to date suggests that regulatory avoidance has

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[145] *See* Cary Coglianese, *Pledging, Populism, and The Paris Agreement: The Paradox of a Management-Based Approach to Global Governance*, 34 MD. J. INT'L L. 139, 167–68 (2019) (stating that many facilities joined Performance Track, a voluntary environmental program in order to be seen as leaders rather than to actually improve environmental performance).

[146] *See* Edward Klump, *Natural Gas and Net Zero: Can They Coexist?*, ENERGYWIRE (Oct. 13, 2021, 6:13 AM), https://perma.cc/4THU-EF2L (saying that "green washing" is a term used by climate advocates to suggest corporate actions are insufficient).

[147] *See, e.g.*, *id.* (noting utility company's pledge to achieve net zero by 2035, excluding Scope 3 emissions, but that such emissions currently account for 83 percent of the company's current GHG emissions).

[148] *See* Joshua Ulan Galperin, *Environmental Governance at the Edge of Democracy*, 39 VA. ENV'T. L.J. 70, 94–97 (2021) (discussing potential for private environmental governance to displace government programs).

not been a primary motivation behind corporate net zero targets,[149] political momentum for such regulation has been building.

Greenwashing aside, net zero targets may fail to live up to their promises for another reason. Namely, the GHG-emitting activities once performed by net zero companies may simply continue under other companies that are not bound by net zero pledges.[150] Such "net zero leakage" could severely undermine the impact of implementing net zero pledges.[151] A prominent example of net zero leakage involves the sell-off by major oil companies of their most heavily polluting assets to small, privately held companies.[152] Such moves reduce the carbon emissions associated with the large companies but yield little if any environmental

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149 *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 150 (noting that many corporations reaffirmed their intent to reduce GHG emissions notwithstanding the Trump Administration's decision to withdraw from the Paris Agreement).

150 *See* John Mulliken, *Big Oil Gets Clean and the World Stays Dirty*, BOSTON GLOBE, https://perma.cc/PX7G-BBT8 (last updated June 10, 2021, 3:00 AM) ("BP sold its oil reserves on Alaska's North Slope to Hilcorp, a private company.").

151 *See id.*

152 *See* Hiroko Tabuchi, *Here Are America's Top Methane Emitters. Some Will Surprise You.*, N.Y. TIMES (June 2, 2021), https://perma.cc/N37Z-7Z2E (last updated Oct. 26, 2021); Mulliken, *supra* note 150 ("But the path of least resistance for them likely will be to sell off the dirtiest parts of their portfolios to private companies whose investors and boards do not face the same scrutiny.").

benefit.[153] In some instances, emissions may even increase because the purchasers—often private companies not subject to investor pressure—are more likely to develop the asset and to operate with lower standards.[154]

B. *Motivations for Governmental Pledges*

Governments do not face the same profit-driven incentives to adopt net zero targets as the private sector. Nonetheless, some climate-related policy changes, such as the elimination of fossil fuel subsidies or the imposition of carbon taxes, would benefit public budgets.[155] Moreover, the adoption of net zero targets by many governments points to policy or political benefits. Governments' net zero targets can align national climate policy with international climate objectives, guide policymaking and decision making, provide certainty

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[153] *See* Tabuchi, *supra* note 152 (stating that smaller companies have no public scrutiny or pressure to improve their environmental targets, and that operating in a green manner is not a priority for their business models).

[154] *See* Carlos Anchondo & Mike Lee, *Oil Majors Are Getting Out of Oil. It Might Spike Emissions*, ENERGYWIRE (June 17, 2021, 7:16 AM), https://perma.cc/5VKC-BMMW (PDF) ("But while the sales would help Shell and other oil companies move closer to meeting their own climate goals . . . historically, asset sales have meant an uptick in emissions.").

[155] *See* Savannah Bertrand, *Fact Sheet: Proposals to Reduce Fossil Fuel Subsidies*, ENV'T & ENERGY STUDY INST. (July 23, 2021), https://perma.cc/G9K3-NBKM ("Eliminating fossil fuel subsidies would save taxpayer dollars while simultaneously reducing greenhouse gas emissions.").

to businesses, investors, and other actors, and shape sustainable long-term development.[156] Credible net zero commitments can reduce the amount of stranded assets and reduce the need for drastic policy interventions down the road.[157] Macroeconomic benefits may include higher levels of investment and reduced fossil fuel imports.[158]

Economic nationalism also may motivate national net zero pledges, as countries seek to promote clean technology industries and employment, foster energy security, and lay the groundwork for carbon border taxes.[159] Net zero policies can help first-movers to develop

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[156] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 5, 21 (describing broad motivations behind the adoption of net zero targets).

[157] *See* GROUP OF 30, *supra* note 126, at 16 ("If ambitious climate targets are seen as credible, businesses will stop investing in high-carbon technologies and in the future, there will be fewer fully depreciated carbon-intensive plants competing against green alternatives.").

[158] *See id.* at 10 ("In many cases, the macroeconomic benefits of higher investments and lower fossil fuel imports may outweigh the macroeconomic costs. . . .").

[159] *See* Daniel A. Farber et al., Thinking Globally, Acting Locally: Lessons from the U.S., Japan, and China 38 (2021) (unpublished manuscript), https://perma.cc/LK9V-QUTM (PDF) ("States may also seek economic advantage from being first-movers on climate change by developing related intellectual property and industries."); Nathanial Gronewold, *More Nations Aim for Net-Zero Emissions by 2050*, CLIMATEWIRE (Nov. 30, 2020).

expertise and new technologies that can provide a long-term competitive advantage.[160] Nations that develop more sustainable, post-industrial economies often will be attractive to businesses and individuals.[161] Indeed, politicians in some countries have campaigned in response to popular support for ambitious climate action.[162] In other countries, however,

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[160] *See* GROUP OF 30, *supra* note 126, at 10 ("[C]ountries that move ahead of others are well-positioned to benefit from the economic opportunities that the transition to net zero brings.").

[161] *See* Farber et al., *supra* note 159, at 43 ("[J]urisdictions. . . . may want to gain or burnish their reputations for being forward-looking and sustainable, which can help attract business and residents for a post-industrial economy.").

[162] *See* GROUP OF 30, *supra* note 126, at xiii–xiv ("An increasing number of politicians have recognized this and campaign on ambitious targets to reduce emissions."). For example, Liberal candidates in Canada promised to commit Canada to achieving net zero emissions by 2050. *See Liberals Move Forward to Legislate Net-Zero Emissions by 2050*, LIBERAL (Sept. 24, 2019), https://perma.cc/7R7V-CSHC ("[A] re-elected Liberal government will take concrete steps to lower emissions and make life more affordable for Canadians."). And during the 2020 campaign, Joe Biden endorsed the goal of achieving net zero emissions in the energy sector by 2035. *See* Adam Aton, *Can the "Biden Green Deal" Appease Progressives?*, CLIMATEWIRE (Oct. 1, 2020, 5:40 AM), https://perma.cc/V2C4-S7M2.

populist movements have pushed in the opposite direction, prompting leaders to attack commitments on climate change and other global matters.[163]

International political pressure is another important factor that can encourage states to make and carry out net zero pledges. The Paris Agreement does not require parties to submit NDCs that would be consistent with the 1.5°C or 2°C temperature goals, nor does it require parties to achieve the commitments set forth in their NDCs.[164] Rather, the agreement assumes that international pressure will lead countries to ratchet up their NDCs over time.[165] National net zero targets function in a similar voluntary and self-determined way as NDCs. Indeed, NDCs could eventually incorporate net zero targets. Unfortunately, with respect to both NDCs and net zero targets, policymakers face incentives to set ambitious

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[163] *See* Coglianese, *supra* note 145, at 176–78 ("The Paris Agreement's flexibility and voluntary nature have so far not kept populist elected leaders in countries such as the United States and Brazil from lambasting it.").

[164] *See* Noah M. Sachs, *The Paris Agreement in the 2020s: Breakdown or Breakup?*, 46 ECOLOGY L.Q. 865, 872 (2019) ("The parties opted for this voluntary approach because a 'tougher' agreement with binding targets and enforceable sanctions would not have attracted the participation of major emitters, including the United States.").

[165] *See id.* at 874–76 ("The ratchet mechanism refers to the provisions of the Paris Agreement that require parties to submit progressively more 'ambitious' NDCs over time.").

goals—while at the same time instituting weak policies unlikely to accomplish those goals.[166] Ultimately, it is not clear that international pressure will be sufficient to compel countries to achieve their NDCs or their net zero pledges. Powerful domestic interests will offer stiff resistance, especially as increasingly stringent emissions reductions become necessary to achieve net zero.[167] Furthermore, "naming and shaming" strategies offer little leverage against voluntary pledges, particularly where widely accepted benchmarks for evaluating those pledges do not exist.[168]

III. REINFORCING NET ZERO TARGETS

Nation-states and corporations have various motivations to make net zero pledges, and perhaps weaker motivations to implement and achieve those pledges. To increase the likelihood of follow-through on net zero commitments, society should develop and implement

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166 *See id.* at 875 ("[T]he ratchet mechanism is a necessary but not sufficient condition for a consistent, upward trajectory of NDCs. Parties must somehow be incentivized to stick with it."); GROUP OF 30, *supra* note 126, at xiv ("Once elected, politicians are hence tempted to skimp on environmental efforts to fuel short-term growth.").

167 *See* Sachs, *supra* note 164, at 876–77 ("In each party's cost-benefit calculus, powerful domestic economic interests will undoubtedly weigh as much or more than concerns about international reputation . . . .").

168 *See* Coglianese, *supra* note 145, at 164–65 (noting that the Paris Agreement "offers no clear, commonly accepted norm with respect to the amount of emissions reductions that any nation should achieve"); Sachs, *supra* note 164, at 876–83 (challenging assumption that peer pressure will consistently support ratcheting up of national pledges under Paris Agreement).

transparency and accountability mechanisms. In addition, both public law and private law offer tools for potentially enforcing net zero pledges notwithstanding their voluntary nature.

A. *Transparency and Verification of Net Zero Targets*

Transparency plays an important role in translating voluntary commitments into meaningful impacts. Public commitments can attract attention, provide clear direction to stakeholders, and promote accountability.[169] Transparency on specific details—including an entity's planned pathway to net zero, emissions reduction measures, actual emissions, and reliance on offsets and carbon removals—will enable distinctions to be drawn between genuine progress toward net zero and mere greenwashing.[170]

With sufficient transparency, nongovernmental organizations, rival companies, the media, investors, and the public can track entities' progress in achieving net zero and highlight their shortcomings.[171] For private climate initiatives, market incentives, peer

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[169] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 19 ("Clearly communicating a net-zero target to domestic and international stakeholders is essential if a genuine commitment to transform economic systems is not to be perceived as political greenwashing.").

[170] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 5, 57–58 ("Such transparency also provides a clearer opportunity for ambitious actors to stand out.").

[171] *See* Light & Orts, *supra* note 134, at 58 (explaining different methods of enforcement with examples from both public and private sectors).

pressure, and reputational risk all can promote accountability.[172] Reporting and review mechanisms common in environmental treaty regimes can serve a similar function for governmental net zero targets.[173]

1. Disclosure Frameworks

In the absence of specific legal mandates, voluntary frameworks and standards for sustainability reporting offer potentially useful guidance on the development and disclosure of net zero targets.[174] A leading voluntary framework, from the Task Force on Climate-related Financial Disclosures (TCFD), includes general recommendations for climate-related

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[172] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 386 ("[P]rivate climate initiatives often do provide some level of accountability by firms to customers, investors, and employees who have preferences for reducing carbon emissions.").

[173] *See* DANIEL BODANSKY, THE ART AND CRAFT OF INTERNATIONAL ENVIRONMENTAL LAW 238–43 (2010) (explaining the different types of reporting mechanisms in environmental treaty regimes, and their pros and cons).

[174] *See* Richard Barker et al., *The Future of ESG Is . . . Accounting?*, HARV. BUS. REV., (Dec. 3, 2020), https://perma.cc/G2DU-BTEA (discussing proposed creation of Sustainability Standards Board that would create a global baseline of sustainability disclosure standards); https://www.ifrs.org/news-and-events/news/2021/11/ifrs-foundation-announces-issb-consolidation-with-cdsb-vrf-publication-of-prototypes/ (announcing formation of International Sustainability Standards Board) .

disclosures.[175] Of particular relevance to net zero targets are recommendations to "[d]isclose Scope 1, Scope 2, and if appropriate, Scope 3 greenhouse gas (GHG) emissions" and to "[d]escribe the targets used by the organization to manage climate-related risks and opportunities and performance against targets."[176] Although the TCFD framework does not expressly mention net zero targets, corporate disclosure of such targets should follow the TCFD's advice to describe timeframes for applying climate-related targets and indicators for assessing progress against targets.[177] Further reporting guidance can be found in standards issued by the Sustainability Accounting Standards Board (SASB) and the Global Reporting Initiative (GRI). The SASB standards concern the reporting of financially material sustainability information—i.e., information that would be useful to investors.[178] The widely

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[175] *See* MADISON CONDON ET AL., MANDATING DISCLOSURE OF CLIMATE-RELATED FINANCIAL RISK 18 (2021), https://perma.cc/93DX-VE9Z (PDF) (discussing "broad support [for the framework] from the investment community, regulators, and corporations").

[176] TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES, RECOMMENDATIONS OF THE TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES 14, 22–23 (2017), https://perma.cc/M9B5-UGX2 (PDF).

[177] *See id.* at 23 (giving guidelines for metrics and targets sectors should adopt).

[178] *See* CONDON ET AL., *supra* note 175, at 19 (stating that the SASB standards "supplement[] the TCFD framework by providing detail and specificity"); Susan N. Gary, *Best Interests in the Long Term: Fiduciary Duties and ESG Integration*, 90 U. COLO. L. REV. 731,

used GRI standards broadly address reporting on economic, environmental, and social impacts, not all of which are relevant to investors.[179]

Voluntary standards specific to net zero targets are being developed. In October 2021, the Science Based Targets Initiative (SBTI) released its "Net-Zero Standard," a document that offers guidance, criteria, and recommendations for large corporations in setting net zero targets.[180] This voluntary standard defines corporate net zero to mean "[r]educing scope 1, 2, and 3 emissions to zero or to a residual level that is consistent with reaching net-zero

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772 (2019) ("The SASB explains that the standards represent 'a complete set of globally applicable industry-specific standards which identify the minimal set of financially material sustainability topics and their associated metrics for the typical company in an industry.'").

[179] *See* Gary, *supra* note 178, at 773–74 ("GRI released the Standards in 2016 to 'enable all organizations to report publicly on their economic, environmental and social impacts . . . ."); Barker et al., *supra* note 174 ("[T]he Global Reporting Initiative (GRI) is focused on the entire range of sustainability issues that matter to society as a whole.").

[180] *See* SCI. BASED TARGETS INITIATIVE, SBTI CORPORATE NET ZERO STANDARD VERSION 1.0, at 4 (2021), https://perma.cc/PH2E-PUAR (PDF) ("Through a transparent multi-stakeholder process, the Science Based Targets initiative (SBTi) has developed the first global science-based standard for companies to set net-zero targets."). SBTI has issued separate guidance for financial institutions and suggested that small- and medium-sized enterprises follow a simplified route for setting net zero targets. *See id.* at 5 (stating that its Net-Zero Standard is meant for corporations with more than 500 employees, and that there are separate guidelines for smaller businesses and financial institutions).

emissions . . . in eligible 1.5°C-aligned pathways" and "[n]eutralizing any residual emissions at the net-zero target year" and beyond.[181] Under this standard, corporate net zero targets should include 5–10 year emissions reduction targets in line with 1.5°C pathways, targets to reduce emissions to a residual level in line with 1.5°C scenarios by 2050, and actions beyond companies' value chains to mitigate emissions or remove carbon.[182]

Government oversight of climate-related corporate disclosures, which to date has been limited, is poised to increase.[183] Securities law requires publicly held companies to disclose material information.[184] The materiality standard refers to "a substantial likelihood that a reasonable shareholder would consider [the information] important in deciding how to

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[181] *Id.* at 8.

[182] *See id.* at 8–10 (describing targets for large corporations).

[183] *See* Virginia Harper Ho, *Modernizing ESG Disclosure*, 2022 U. ILL. L. REV. 277, 286-88 ("Demand for ESG disclosure reform has risen rapidly over the past decade, driven by growing consensus among mainstream investors that all companies should disclose material ESG information . . . ."); CONDON ET AL., *supra* note 175, at 10, 21–22 (observing that climate-related disclosures have "failed to result in comparable, specific, and decision-useful climate risk disclosure," often because of their incompleteness and boilerplate nature).

[184] *See* TSC Indus., Inc. v. Northway, Inc., 426 U.S. 438, 449 (1976) ("What the standard does contemplate is a showing of a substantial likelihood that, under all the circumstances, the omitted fact would have assumed actual significance in the deliberations of the reasonable shareholder.").

vote."[185] Securities and Exchange Commission (SEC) guidance on climate-related disclosures, issued in 2010, observes that climate change may trigger required disclosures in terms of impacts of climate change legislation and regulation, indirect consequences of regulation or business trends, and climate change's physical impacts.[186] The guidance focuses on disclosure of impacts and risks, rather than forward-looking objectives such as net zero targets.[187] Nonetheless, as the SEC proceeds with rulemaking on climate-related disclosures, the agency

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[185] *Id.*; *see generally* CONDON ET AL., *supra* note 175, at 12–13 ("The materiality standard is a self-imposed limitation on the typical scope of the SEC's disclosure requirements, and the Commission has occasionally required disclosures untethered from a materiality assessment.").

[186] Commission Guidance Regarding Disclosure Related to Climate Change, 75 Fed. Reg. 6290, 6290 (Feb. 8, 2010) (to be codified at 17 C.F.R. pts. 211, 231 and 241) (The Securities and Exchange Commission . . . is publishing this interpretive release to provide guidance to public companies regarding the Commission's existing disclosure requirements as they apply to climate change matters.").

[187] *See id.* at 6297 ("This interpretive release is intended to remind companies of their obligations under existing federal securities laws and regulations to consider climate change and its consequences as they prepare disclosure documents to be filed with us and provided to investors.").

has proposed to require companies to report and disclose specific metrics such as GHG emissions and reduction goals.[188]

Legislative proposals to mandate climate-related disclosure include both federal and state bills. At the federal level, the Paris Climate Agreement Disclosure Act would amend the 1934 Securities Exchange Act to require public companies to report on whether they have "set or . . . committed to achieve, targets that are a balance between greenhouse gas emissions and removals, at a pace consistent with [Paris's temperature goals]."[189] Companies that have not set or committed to set such targets would be required to explain their failure to do so. The Climate Risk Disclosure Act would require public companies to report GHG

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[188] *See* Enhancement and Standardization of Climate-Related Disclosures for Investors, __ Fed. Reg.__ (Mar. __, 2022), https://www.sec.gov/rules/proposed/2022/33-11042.pdf (proposed rule); SEC, Enhancement and Standardization of Climate-Related Disclosures, Mar. 21, 2022, https://www.sec.gov/files/33-11042-fact-sheet.pdf (summarizing proposed rule). Regulators in the United Kingdom, the European Union, Mexico, and New Zealand are considering requirements that companies make TCFD-compliant disclosures. *See* GROUP OF 30, *supra* note 126, at 29 ("To support the progress being made on the voluntary and private sector side, authorities around the world need to set out a timetable for making TCFD-compliant disclosure mandatory.").

[189] Paris Climate Agreement Disclosure Act (Discussion Draft), 117th Cong., 1st Sess. § 3(a)(1)(A) (2021), https://perma.cc/FX9M-VGRY (PDF).

emissions and potential financial impacts of climate change.[190] And at the state level, California's proposed Climate Corporate Accountability Act initially sought to require large companies doing business in the state to set science-based emission targets consistent with Paris's 1.5°C temperature goal, although this requirement has since been deleted from the bill.[191]

2. Benchmarking and Third-Party Certification

Disclosure requirements would not make emissions targets or net zero targets enforceable. However, disclosure requirements could foster standardization of reporting and target-setting, thereby making it easier for stakeholders and the public to draw comparisons between companies, evaluate the ambition of targets, and hold companies accountable for their progress (or lack thereof) in achieving them.

An important way in which disclosure can promote accountability is by enabling benchmarking of net zero strategies and the establishment of scorecards that analyze

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190 *See* H.R. 2570, 117th Cong. (2021) (setting out disclosure requirements of GHG emissions for public companies).

191 *See* S.B. 260, Cal. Leg., Reg. Sess. (Cal. 2021), https://perma.cc/5ARV-MXD3 (explaining that the act would require businesses to make certain disclosures regarding their GHG emissions).

company performance in an accessible format.[192] For example, the Climate Action 100+ Net Zero Company Benchmark assesses major carbon-emitting companies with respect to their net zero ambition, emissions reductions targets and goals, decarbonization strategy, capital allocation alignment, and other indicators.[193] In regard to short-term emissions targets, a company is assessed on whether it has set a target between 2020 and 2025 for reducing emissions, whether any such target covers at least 95 percent of Scope 1 and 2 emissions, whether the company has set a Scope 3 emissions target, and whether the company's short-term target is aligned with a trajectory to achieve Paris's 1.5°C goal.[194] The assessment's purpose is to set corporate expectations and inform corporate actions, establish

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[192] *See* Louis G. Leonard, *Under the Radar: A Coherent System of Climate Governance, Driven by Business*, 50 ENV'T. L. REP. 10546, 10561 (2020) ("Just as setting a target seems to unlock innovative capacity to implement it, setting a target also should trigger corporate self-governance processes to drive compliance.").

[193] *See* CLIMATE ACTION 100+, 2020 PROGRESS REPORT 11 (2020), https://perma.cc/ZUS7-ED5M (PDF) (explaining updates on how Climate Action 100+ evaluates companies). Assessments of individual companies can be found at *Companies*, CLIMATE ACTION 100+, https://perma.cc/8RH2-SJTH. The Benchmark "does not interrogate the quality of company decarbonisation strategies directly." *Frequently Asked Questions*, CLIMATE ACTION 100+, https://perma.cc/D3MP-HA96.

[194] *See* CLIMATE ACTION 100+, 2020 PROGRESS REPORT *supra* note 193, at 17 (describing disclosure indicators for companies).

a mechanism for tracking progress, and provide a tool for investors to evaluate and engage with companies.[195]

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[195] *See id.* at 14–15 ("Climate Action 100+ seeks to focus investor action on the world's largest GHG emitters, including emissions across the value chain, and companies that present the greatest climate-related risk to investors' portfolios or that have a significant opportunity to drive a broader net-zero economy transition."). For specified sectors, the Benchmark also considers companies' capital expenditures and output relative to a range of climate change scenarios. For example, with respect to capital allocation by electric utilities, the Benchmark assesses a company's projected technology mix compared to the market average and whether a company has announced a full phase-out of coal or gas units by 2040. *See id.* at 21 ("The capital allocation indicators are designed to complement the disclosure indicators by providing further insights to investors regarding the adequacy of companies' capital allocation plans, and relative alignment with the company's stated emissions reduction targets.").

Third-party certification of net zero efforts can reinforce carbon disclosure.[196] Various entities offer carbon neutrality certifications for specific products, activities, or companies.[197] Such certifications may serve as initial steps towards implementing net zero targets but do not necessarily warrant that a company is achieving net zero from society's overall perspective. This is because carbon neutrality certifications generally do not account for

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[196] *See* Graeme Auld & Lars H. Gulbrandsen, *Private Regulation in Global Environmental Governance*, *in* THE HANDBOOK OF GLOBAL CLIMATE & ENVIRONMENTAL POLICY 394, 405 (Robert Falkner, ed., 2013), https://perma.cc/S59T-WFRN (PDF) (noting that Carbon Disclosure Project (CDP) discloses corporate responses and summary analyses of companies' climate-related activities but does not set standards for corporate performance).

[197] *See, e.g.*, NATURAL CAPITAL PARTNERS, THE CARBONNEUTRAL PROTOCOL: THE GLOBAL STANDARD FOR CARBON NEUTRAL PROGRAMMES 26 (2021), https://perma.cc/4T4W-BAJG (PDF) ("To provide consistency across a wide range of possible situations, The Protocol provides for a number of different CarbonNeutral certifications corresponding to different possible entities, products and activities."); Claire Elise Thompson, *"Climate Neutral" Products Are Now a Thing. What's Behind the Label?*, GRIST (Mar. 3, 2021), https://perma.cc/5HCP-SH5Y (describing Climate Neutral Certified, a nonprofit attempting to hold businesses to higher standards to maintain good practices for the environment).

Scope 3 emissions, and companies may offset their emissions through carbon credits that may not represent the permanent removal of carbon from the atmosphere.[198]

By encouraging green innovation and improvements in production processes, environmental certification programs can complement traditional regulation and promote public ends.[199] The oversight potentially provided by certification systems can be especially valuable in the absence of government regulation.[200] However, certification systems themselves may be subject to concerns about credibility, transparency, and cost, and consumers may not be able to readily judge the meaning of a particular certification or

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198 *See Briefing: Net Zero for Corporates*, CARBON TRUST, https://perma.cc/2JPV-TW8N (stating that companies should report progress against targets annually and include "fully disaggregated emissions and removals in the GHG Inventory, broken down by Scope 1, 2, and 3); *see, e.g.*, *Climate Neutral Certified Brands*, CLIMATE NEUTRAL, https://perma.cc/7CVC-KKNK (listing 338 brands that have become Climate Neutral Certified); Natural Capital Partners, supra note 197, at 28–29, 63.

199 *See* Albert C. Lin, *Power to the People: Restoring the Public Voice in Environmental Law*, 46 AKRON L. REV. 1017, 1035 (2013) (explaining the promise of environmental certification).

200 *See id.* at 1022 ("Finally, the government's struggles to address environmental challenges suggest general limitations to the ability of conventional regulation alone to adequately respond to these challenges.").

distinguish between different certifications.[201] Ideally, third-party certification of net zero efforts would offer transparency on certification standards and procedures, include audits of the companies they certify, and clearly communicate the meaning of certification.[202]

* * *

The net zero transparency and accountability efforts discussed above focus primarily on the private sector, but disclosure and verification requirements could apply similarly to government net zero targets. Government pledges are already being tracked on several websites, including Climate Watch's Net Zero Tracker[203] and the United Nations' Climate Action website.[204] Such websites should include coverage of specific commitments and plans underlying net zero pledges as nations flesh them out. Furthermore, incorporating net zero pledges or elements of those pledges into NDCs would trigger an array of accountability mechanisms found in the Paris Agreement. These mechanisms include incorporation of

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[201] *See id.* at 1036–37 (discussing credibility, transparency, and accountability concerns because consumers must rely on certifiers to determine whether a product was produced in an environmentally friendly manner).

[202] *See id.* at 1037 (stating that parties with access to information on third-party certifiers' finances, evaluation criteria, and monitoring processes can assess the credibility of certification schemes).

[203] *Net-Zero Tracker*, CLIMATE WATCH, https://perma.cc/XZ7X-3X7L.

[204] *Net-Zero Coalition*, U.N.: CLIMATE ACTION, https://perma.cc/2JUH-GDAW.

NDCs in a public registry, reports of progress in implementing NDCs, technical expert review, and multilateral peer review.[205]

B. *Enforcement of Private Net Zero Targets*

Ensuring that entities implement net zero targets is challenging. While voluntary commitments by definition are not legally enforceable, various mechanisms are available to pressure companies to follow through on their net zero pledges. In the U.S., such mechanisms include securities fraud litigation, consumer protection actions, contractual arrangements, and consumer and investor pressure.[206]

1. Securities Fraud Litigation

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[205] *See* Paris Agreement arts. 4, 13, *supra* note 18 (outlining accountability mechanisms); *see also* U.N. CLIMATE CHANGE SECRETARIAT, REFERENCE MANUAL FOR THE ENHANCED TRANSPARENCY FRAMEWORK UNDER THE PARIS AGREEMENT (2020), https://perma.cc/2WX5-9EBB (PDF) (offering guidance to technical expert reviewers in fulfilling their tasks under the Paris Agreement).

[206] Other mechanisms may be available outside the U.S. For example, the Dutch trial court decision in *Vereniging Milieudefensie v. Royal Dutch Shell* relied on an "unwritten standard of care" in the Dutch Civil Code to require Shell Oil to reduce its CO_2 emissions by at least 45 percent by 2030. Rechtbank Den Haag [Court of the Hague] 26 mei 2021, ECLI:NL:RBDHA:2021:5339, 4.4.1, 5.3 (Vereniging Milieudefensie/Royal Dutch Shell).

Plaintiffs are just beginning to test the potential for securities fraud claims to police climate disclosures. Section 10(b) of the Securities Exchange Act of 1934[207] makes it unlawful "to use or employ, in connection with the purchase or sale of any security . . . any manipulative or deceptive device . . . ."[208] Rule 10b-5 specifies that such unlawful conduct includes the making of an untrue statement of a material fact or the omission of a material fact.[209] "In a typical § 10(b) private action a plaintiff must prove (1) a material misrepresentation or omission by the defendant; (2) scienter; (3) a connection between the misrepresentation or omission and the purchase or sale of a security; (4) reliance upon the misrepresentation or omission; (5) economic loss; and (6) loss causation."[210]

While the case law on Section 10(b) actions involving sustainability disclosures is limited, courts have tended to look more favorably on claims involving "concrete, repetitive, and fact based" disclosures, as opposed to disclosures that "contain 'vague' and 'aspirational' language."[211] This distinction suggests that distant net zero targets may prove less actionable than more immediate and concrete goals. While courts may hesitate to enforce even the latter

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207 15 U.S.C. § 78.

208 *Id.* § 78j(b).

209 17 C.F.R. § 240.10b-5.

210 Stoneridge Inv. Partners, LLC v. Scientific-Atlanta, Inc., 552 U.S. 148, 157 (2008).

211 Caitlin M. Ajax & Diane Strauss, *Corporate Sustainability Disclosures in American Case Law: Purposeful or Mere "Puffery"?,* 45 ECOLOGY L.Q. 703, 706 (2018).

because of their forward-looking nature,[212] investors' growing interest in, and use of, climate-related information increases the likelihood that courts will find such information material.[213] Indeed, the fact that a corporate statement is contingent or future-oriented does not preclude a materiality finding.[214] Predictive statements can serve as a basis for liability if they were false at the time they were made and were unaccompanied by meaningful cautionary language.[215]

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[212] *See id.* at 707 (suggesting that "most sustainability disclosures and public sustainability commitments from companies are . . . 'aspirational'").

[213] *See* Hana V. Vizcarra, *The Reasonable Investor and Climate-Related Information: Changing Expectations for Financial Disclosures*, 50 ENV'T L. REP. 10106, 10107 (2020) ("The shift in how reasonable investors view climate-related information means companies can no longer make materiality determinations the way they always have. As more reasonable investors consider such information material, the likelihood increases that courts will.").

[214] *See* Ajax & Strauss, *supra* note 211, at 717 (noting the Supreme Court holding in Basic Inc. v. Levinson, 485 U.S. 224, 238 (1988), that "materiality" in the context of contingent and/or speculative information will depend on "'a balancing of both the indicated probability that the event will occur and the anticipated magnitude of the event in light of the totality of the company activity'").

[215] *See In re* BP P.L.C. Sec. Litig., 843 F. Supp. 2d 712, 747–48 (S.D. Tex. 2012) ("Where the forward-looking statement is not accompanied by cautionary language, a plaintiff must

Lawsuits alleging that Exxon Mobil misled investors with respect to climate change costs hint at how courts might address Section 10(b) misrepresentation claims involving net zero targets. The leading case was brought by New York under a state law governing securities fraud.[216] That law, which incorporates the federal standard of materiality, prohibits a misrepresentation of material facts in connection with the issuance, purchase, or sale of securities.[217] New York alleged that Exxon Mobil misled investors by disclosing publicly a proxy cost of carbon that reflected possible climate regulations while relying internally on GHG projections that did not account for such regulation.[218] Finding Exxon Mobil's disclosures not misleading, the trial court reasoned that the proxy cost of carbon

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demonstrate that the defendant made the statement with 'actual knowledge' as to its falsity."); Vizcarra, *supra* note 213, at 10108 ("There is also a statutory protection for forward-looking statements when accompanied by meaningful cautionary statements or when not made with actual knowledge that the statement was misleading.").

216 *See* New York v. Exxon Mobil Corp., No. 452044/2018, 2019 WL 6795771, at *3 (N.Y. Sup. Ct. 2019) (explaining the Martin Act).

217 *See id.* at *3 (stating that the law "prohibits the use of 'any device, scheme or artifice . . . deception, misrepresentation, concealment, suppression, fraud, false pretense or false promise' in connection with the 'issuance, exchange, purchase, sale, promotion, negotiation, advertisement, investment advice or distribution' of securities").

218 *Id.* at *12–*13. *But cf.* Ramirez v. Exxon Mobil Corp., 334 F. Supp. 3d 832, 847 (N.D. Tex. 2018) (denying Exxon's motion to dismiss claim that use of proxy cost of carbon that differed from GHG costs could constitute material misrepresentation under Section 10(b)).

metric and internal GHG projections served different purposes and that no actual investors were misled.[219] The court also found any alleged disinformation not material because "no reasonable investor would have viewed speculative assumptions about hypothetical regulatory costs projected decades into the future as significantly altering the total mix of information available."[220] The court's reasoning, if applied to net zero targets, does not rule out Section 10(b) claims.[221] However, it does suggest that courts will carefully consider the nature of a company's assumptions and the timeframe of future projections.

2. Federal and State Consumer Protection Laws

State consumer protection laws, as well as the Federal Trade Commission's (FTC) authority over unfair or deceptive practices, also could serve as sources of leverage with respect to corporate net zero targets.

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219 *See Exxon Mobil*, 2019 WL 6795771, at *15.

220 *Id.* at *19 (internal quotation omitted).

221 *See* Hana Vizcarra, *Understanding the* New York v. Exxon *Decision*, HARVARD L. SCH. ENV'T & ENERGY L. PROGRAM (Dec. 12, 2019), https://perma.cc/EK7H-B7CT ("This case does not preclude climate-related information from being material, whether disclosed through voluntary or mandatory disclosures.").

Section 5 of the FTC Act[222] authorizes the FTC to police "unfair or deceptive acts or practices in or affecting commerce";[223] an act or practice is deceptive if it is likely to mislead, even if it does not cause actual deception.[224] The agency's "Green Guides" provide guidance on environmental claims that may qualify as unfair or deceptive.[225] Enforcement against green marketing claims has historically focused on testable, product-specific claims, such as false claims that a product is biodegradable or incorporates recycled content.[226] Enforcement

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222 15 U.S.C. § 41 *et seq*.

223 15 U.S.C. § 45(a)(1). "Deception" is defined as "a representation, omission or practice that is likely to mislead the consumer acting reasonably in the circumstances, to the consumer's detriment." Cliffdale Assocs., Inc., 103 F.T.C. 110, 176 (1984).

224 *See* David Hackett et al., *Growing ESG Risks: The Rise of Litigation*, 50 ENV'T L. REP. 10849, 10853 (2020) ("Notably, in order for the FTC to find a company's conduct to be improperly deceptive, the company need not actually deceive or even intend to deceive a consumer.").

225 *See* FTC Guides for the Use of Environmental Marketing Claims, 16 C.F.R. § 260.1(a) (2012) (explaining the purpose of the guides).

226 *See* Robin N. Rotman et al., *Greenwashing No More: The Case for Stronger Regulation of Environmental Marketing*, 72 ADMIN. L. REV. 417, 422, 434 (2020) (discussing cases in which the FTC challenged claims such as "100% biodegradable" and "compostable"); Timothy C. Bradley, *Likelihood of Eco-Friendly Confusion: Greenwashing and the FTC "Green Guides*", LANDSLIDE (Sept./Oct. 2011), https://perma.cc/GUX7-3GFY (PDF) (summarizing efforts to curtail greenwashing).

with respect to net zero pledges may be trickier, given the distant timeframes at issue, the focus of such pledges on a company's overall emissions rather than emissions associated with a specific product, and the various ways of defining net zero.[227] Nonetheless, nongovernmental organizations recently filed a complaint with the FTC against Chevron with respect to its broad statements of environmental commitments.[228] The complaint alleges that Chevron overstated in advertisements its investments in renewable energy and its commitment to reducing fossil pollution and requests that Chevron stop its deceptive marketing efforts and disseminate corrective statements.[229]

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[227] *See* Kelly Levin et al., *What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered*, WORLD RES. INST. (Sept. 17, 2019) [hereinafter Levin et al., *What Does "Net-Zero Emissions Mean?*], https://perma.cc/5EZZ-4SNZ (discussing critiques of net zero targets).

[228] *See* Kevin Crowley, *Chevron 'Greenwashing' Targeted in Complaint Filed With FTC*, BLOOMBERG (Mar. 16, 2021, 8:00 AM), https://perma.cc/8FUL-L2R5 ("Chevron's pledge of 'ever-cleaner energy' amounts to so-called greenwashing because it hides the reality that the company's production plans may end up increasing absolute emissions, according to Global Witness, Greenpeace USA and Earthworks.").

[229] *See* Press Release, Earthworks, Accountability Groups File First of Its Kind FTC Complaint Against Chevron for Misleading Consumers on Climate Action (Mar. 16, 2021) (asserting that "[t]he complaint would be the first to petition the FTC to use its Green Guides against a fossil fuel company for misleading consumers on the climate and environmental impact of its operations").

State consumer protection laws may offer a similar mechanism to enforce corporate net zero targets.[230] State consumer protection claims alleging misleading sustainability information have typically centered on product labels, although an increasing number of cases have focused on company environmental, social, and governance (ESG) statements.[231] In adjudicating these claims, courts have distinguished company commitments and statements of "specific and verifiable facts," which are more likely to be actionable, from merely "aspirational" and forward-looking statements.[232]

Several states have filed lawsuits alleging that fossil fuel companies' deceptive advertising, marketing, and communications violated state consumer protection laws.[233]

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[230] Unlike the FTC Act, state consumer protection acts allow private parties to bring claims. *See* Henry N. Butler & Joshua D. Wright, *Are State Consumer Protection Acts Really Little-FTC Acts?*, 63 FLA. L. REV. 163, 164, 173 (2011) (explaining differences between state and federal consumer protection laws).

[231] *See* Hackett et al., *supra* note 224, at 10851–52 ("While consumer claims most commonly challenge product labeling, plaintiffs have begun to extend the reach of these state consumer laws, setting their sights on company ESG statements made in various forms.").

[232] *See id.* at 10852–53 (quoting Nat'l Consumers League v. Wal-Mart Stores, Inc., No. 2015 CA 007731 B, 2016 WL 4080541, at *6 (D.C. Super. Ct. July 22, 2016)).

[233] *See* Jennifer Hijazi, *States Test New Climate Strategies in Big Oil Showdowns*, E&E NEWS (June 29, 2020, 5:51 AM), https://perma.cc/45EF-STF6 ("The top attorneys for the District of Columbia and Minnesota last week launched major lawsuits against the oil and gas industry, adding to a growing swell of climate battles focused on consumer protection.").

These include: a complaint filed by Massachusetts alleging that Exxon Mobil violated the state's consumer protection law through deceptive greenwashing campaigns and material misrepresentations to investors about its use of a proxy cost of carbon;[234] a complaint filed by Connecticut alleging that Exxon Mobil engaged in deceptive greenwashing in violation of the state's unfair trade practices act;[235] a lawsuit filed by the District of Columbia alleging that deceptive advertising, marketing, and communications by multiple oil companies constituted unfair and deceptive trade practices;[236] and a complaint filed by Vermont alleging similar claims under Vermont law.[237]

These lawsuits, if successful, could lay the foundation for future allegations that a company's net zero pledge constituted unlawful greenwashing or deceptive marketing. Courts nonetheless may hesitate to premise liability on net zero targets because of their

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[234] Complaint at 197–98, 202–04, Massachusetts v. Exxon Mobil Corp., No. 19-03333, 2019 WL 11666641 (Mass. Super. Ct. Nov. 29, 2019).

[235] Complaint at 36–43, Connecticut v. Exxon Mobil Corp., No. 3:20-cv-1555, 2021 WL 2389739 (D. Conn. June 2, 2021).

[236] Complaint at 67–77, District of Columbia v. Exxon Mobil Corp. et al., No. 2020 CA 002892 B (D.C. Super. Ct. June 25, 2020).

[237] Complaint at 64–67, Vermont v. Exxon Mobil Corp. et al., (Vt. Super. Ct. Sept. 14, 2021), https://perma.cc/XJ5V-2CXP (PDF).

forward-looking and aspirational nature[238] and their company-wide scope.[239] Even if courts find liability, it is not clear that they would require companies to follow through on their pledges. Remedies in consumer protection cases typically involve actual or punitive damages, restitution, or perhaps injunctive relief barring further misrepresentations or requiring corrective statements.[240]

3. Enforcement by Contract

Contractual arrangements, by creating enforceable rights that do not otherwise exist, can be useful mechanisms for promoting accountability. Some corporations and institutions

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[238] *See* Ajax & Strauss, *supra* note 211, at 725 (discussing the holding in Ruiz v. Darigold, Inc., No. C14-1283RSL, 2014 WL 5599989, at *4 (W.D. Wash. Nov. 3, 2014), that forward-looking, aspirational statements in a CSR report did not constitute a misrepresentation that would likely deceive a reasonable consumer).

[239] *See id.* at 724 (noting that in applying state consumer protection laws, courts have "narrowed the definition of 'material' information to that concerning product defect or product safety").

[240] *See* Victor E. Schwartz & Cary Silverman, *Common-Sense Construction of Consumer Protection Acts*, 54 U. KAN. L. REV. 1, 22–24 (2005) (discussing remedies available to private litigants).

already require suppliers to meet specified sustainability standards.[241] Net zero targets also could be integrated into supply chain contracts and enforced by manufacturers and retailers.[242] Indeed, a wide variety of contractual mechanisms—including loan agreements, development agreements, and settlements—could be crafted to encourage net zero implementation.[243]

The use of contractual financing arrangements to advance environmental goals is not unprecedented. For example, sustainability-linked bonds peg the interest rate a company pays investors on whether the company achieves specified environmental and other goals.[244]

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[241] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 144 ("Corporations that buy materials from others may create supply chain contracting requirements for carbon emissions reductions for a variety of reasons, including not only to reduce costs and enhance reputation but also to increase control over and certainty about supplies of raw materials and other goods.").

[242] *See* Light & Orts, *supra* note 134, at 69 (arguing that supply chain standards imposed by contract are more durable than standards a firm imposes on itself).

[243] *See, e.g.*, *id.* at 43 (discussing the Equator Principles, which require financial firms to undertake environmental impact assessments when making loans to support large-scale infrastructure projects).

[244] *See* Kristin Broughton, *Companies Test a New Type of ESG Bond with Fewer Restrictions*, WALL ST. J. (Oct. 5, 2020, 5:30 AM), https://perma.cc/FBK8-DC4S (stating that

Similarly, an agreement between asset manager BlackRock and a group of banks links BlackRock's lending costs to its ability to achieve specified environmental, social, and governance goals.[245] Under such arrangements, regular reporting of a company's performance with respect to those goals and third-party verification of performance are essential.[246] Financing arrangements have yet to incorporate net zero targets, and the distant timeframes often associated with such targets can pose a challenge in ensuring accountability.[247] Nonetheless, these instruments could be designed to assess a company's

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sustainability-linked bonds are usually structured so that companies pay a higher interest rate to investors if they fail to achieve environmental goals before the maturity date). In contrast to traditional green bonds, whose proceeds must be used for "green" or environmentally-oriented projects, sustainability-linked bonds' proceeds may be used for general business purposes and are generally subject to less burdensome disclosure requirements. *Id.*

[245] *See* Dawn Lim, *BlackRock Must Hit ESG Targets or Pay More to Borrow Money*, WALL ST. J. (Apr. 7, 2021, 12:30 AM), https://perma.cc/96PV-P9V2 (discussing the firm's commitment to sustainable-business goals to keep its corporate borrowing costs down).

[246] *See* INT'L CAP. MKT. ASS'N, SUSTAINABILITY-LINKED BOND PRINCIPLES: VOLUNTARY PROCESS GUIDELINES 2 (2020), https://perma.cc/Q9DT-8QHH (PDF) (listing verification as one of the five core components of the Sustainability-Linked Bond Principles).

[247] *See* Levin et al., *What Does "Net-Zero Emissions Mean?*, *supra* note 227 (arguing that decision-makers must take distant timelines into account by establishing near-term milestones on the path to net zero emissions).

performance in terms of interim targets or concrete goals. For example, a company might be expected to reduce net carbon emissions 50 percent by 2025 or to use energy only from renewable sources by 2025.

Other types of contracts could incorporate net zero targets in whole or in part. Development agreements between a company and a local government or good neighbor agreements between a company and a community might incorporate elements of net zero implementation plans.[248] Settlements of environmental lawsuits also might include net zero targets.[249] Climate change-related public nuisance claims against major oil companies may be logical candidates for such settlements, as at least some of the primary defendants in such cases—BP, Shell, Occidental, and Total—have made net zero pledges.[250] Similarly,

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[248] *See* Douglas Kenney et al., Nat. Res. L. Ctr., Evaluating the Use of Good Neighbor Agreements for Environmental and Community Protection: Final Report 13–14 (2004) (stating that environmental good neighbor agreements are rare, but that case studies suggest that they are effective when used in appropriate circumstances).

[249] *See, e.g.*, Michael Wines, *Duke Energy to Pay Fine Over Power Plant Violations*, N.Y. TIMES (Sept. 10, 2015), https://perma.cc/6ZQA-GBTW (discussing Duke Energy's settlement regarding the violation of Clean Air Act regulations in the 1990s).

[250] *See, e.g.*, Complaint at 13–14, 58–63, City of New York v. BP et al., 325 F. Supp. 3d 466 (S.D.N.Y. 2018) (No. 18 Civ. 182) (stating that the defendants' conduct constitutes substantial and unreasonable interference with and obstruction of public rights and

companies that are being prosecuted for environmental violations could be required to meet net zero targets as part of a consent decree.[251] Many companies that have made net zero pledges also have been the subject of serious or multiple environmental prosecutions in recent

property); *see also* County of San Mateo v. Chevron et al., 295 F. Supp. 3d 934, 937 (N.D. Cal. 2018) (explaining that the claim against the defendants was that their contributions to greenhouse gas emissions constituted a "substantial and unreasonable interference with public rights").

[251] *See, e.g.*, United States v. Alcoa, 533 F.3d 278, 281 (5th Cir. 2008) (stating that defendant company entered into a consent decree that permitted construction of a new power plant with specified emissions limitations after being sued for a violation of the Clean Air Act).

years—including Volkswagen,[252] GM,[253] Duke Energy,[254] Xcel Energy,[255] and Rio Tinto.[256] Incorporating net zero targets into settlements of nonenvironmental violations would reach an even broader range of companies.

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[252] *See What Becoming 'Carbon Neutral' Means to Volkswagen – and Why It's the Only Way Forward,* VOLKSWAGEN (June 24, 2019), https://perma.cc/3MHL-5S83 (pledging carbon neutrality by 2050). In 2016 and 2017, Volkswagen entered into multibillion dollar settlements with the EPA to resolve claims that it sold 590,000 vehicles equipped with computer software designed to cheat on emissions tests. *See Volkswagen Clean Air Act Civil Settlement*, EPA, https://perma.cc/S84N-LALG ("These settlements resolve allegations that Volkswagen violated the Clean Air Act by the sale of approximately 590,000 model year 2009 to 2016 diesel motor vehicles equipped with 'defeat devices.'").

[253] *See General Motors, the Largest U.S. Automaker, Plans to Be Carbon Neutral by 2040*, GENERAL MOTORS (Jan. 28, 2021), https://perma.cc/ULL3-A6ZF (pledging carbon neutrality by 2040). See *Violation Tracker Parent Company Summary,* GOOD JOBS FIRST (2021), https://perma.cc/JS8F-33E8, for a list of legal violations by GM, including environmental violations.

[254] *See Duke Energy Aims to Achieve Net-Zero Carbon Emissions by 2050,* DUKE ENERGY (Sept. 17, 2019), https://perma.cc/Y4LH-E85M (pledging to achieve net zero carbon emissions by 2050). In 2015, Duke's subsidiaries pleaded guilty to criminal violations of the Clean Water Act resulting from a coal ash spill and agreed to pay over $100 million in fines and

4. Enforcement by Consumers and Investors

Consumers and investors also can pressure corporations to make and implement net zero pledges. Tools of consumer pressure include not only individual purchasing behavior—which may be of limited effectiveness[257]—but also boycotts and other campaigns aimed at pressuring target companies as well as institutions and organizations associated with

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environmental projects. *See Summary of Criminal Prosecutions*, EPA, https://perma.cc/7G5S-RBRJ. In the same year, Duke also agreed to pay over $5 million to settle alleged Clean Air Act violations. *See* Wines, *supra* note 249 (stating that the settlement will finance projects ranging from electric-vehicle charging stations at rest stops to the replacement of wood burning stoves).

[255] See *Planning Our Clean Energy Future*, XCEL ENERGY, https://perma.cc/23TY-83ZH (pledging to produce carbon-free electricity by 2050). See *Violation Tracker Parent Company Summary*, GOOD JOBS FIRST, https://perma.cc/3SH2-BH76, for a list of legal violations by Xcel, including environmental violations.

[256] *See Climate Change*, RIO TINTO (2020), https://perma.cc/KS74-GQMM (announcing ambition to achieve net zero by 2050); *see also* Livia Albeck-Ripka, *Abandoned Rio Tinto Mine Is Blamed for Poisoned Bougainville Rivers*, N.Y. TIMES (Sept. 30, 2020), https://perma.cc/PPU3-HHUL (reporting on alleged environmental and human rights violations arising out of Rio Tinto's failure to clean up an abandoned mine in Papua New Guinea).

[257] *See supra* text accompanying notes 133–135.

them.[258] Reputational harm may undermine a company's ability to attract employees and customers.[259]

Tools of investor pressure include climate-related divestment initiatives, screening out of carbon-intensive investments, and shareholder resolutions, all of which can focus the attention of management and the public on climate issues.[260] The impacts of such efforts to date is uncertain, however; climate-related divestment initiatives apparently have been too modest to affect share prices, and climate-related shareholder resolutions often receive a

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[258] *See* Douglas A. Kysar, *Sustainable Development and Private Global Governance*, 83 TEX. L. REV. 2109, 2152–53 (2005); R. Henry Weaver, *Is Consumer Activism Economic Democracy?*, 22 U. PA. J.L. & SOC. CHANGE 241, 256–67 (2019).

[259] *See* Daniel C. Esty & Quentin Karpilow, *Harnessing Investor Interest in Sustainability: The Next Frontier in Environmental Information Regulation*, 36 YALE J. REG. 625, 632–33 (2019).

[260] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 146–47; Peter Newell, *Civil Society, Corporate Accountability and the Politics of Climate Change*, 8 GLOB. ENV'T POL. 122, 142 (2008).

small share of votes.[261] The basic tenets of corporate law—including shareholder primacy and the for-profit nature of corporations—appear quite difficult for such efforts to overcome.[262]

Nonetheless, net zero commitments by major investors themselves could play a critical role in ensuring that corporations carry out their net zero pledges. Especially important, Vanguard and other large asset managers have turned to ESG as a tool for mitigating risks because they cannot readily liquidate or diversify their holdings.[263] Bound by their fund strategies to hold shares in specific companies or industries, these managers

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[261] *See* VANDENBERGH & GILLIGAN, *supra* note 124, at 146–47 (stating that although climate-related resolutions typically receive only a small share of votes, they still attract publicity and increase pressure for emissions disclosure and reductions); *see also* Jonathan M. Gilligan, *Carrots and Sticks in Private Environmental Governance*, 6 TEX. A&M L. REV. 179, 190 (2018) (discussing analyses generally finding "no important impact of divestment campaigns on share prices").

[262] *See* Stavros Gadinis & Amelia Miazad, *Corporate Law and Social Risk*, 73 VAND. L. REV. 1401, 1416–18 (2020) (suggesting that voluntarily expending resources on sustainable outcomes might run afoul of boards' and managers' duties); *see also* Newell, *supra* note 260, at 148 (noting that governance through such nonstate actors tends to yield forms of accountability that are "temporary, unenforceable, [and] subject to tokenism and publicity cycles").

[263] *See* Gadinis & Miazad, *supra* note 262, at 1449 (noting that BlackRock, State Street, and Vanguard, which have started to support ESG efforts, each "controls, on average, 5% to 8% of every publicly traded U.S. company, often qualifying as the biggest shareholder").

adopt a longer-term approach to shareholder value that takes into account at least some factors that may escape quarterly earnings reports.[264] Under the Paris Aligned Investment Initiative's Net Zero Asset Owners Commitment, the leading investor effort on net zero, investors agree to achieve net zero portfolios by 2050 or sooner and to set interim emission reduction targets for 2030 or sooner.[265] The investors that have entered into this commitment, representing some $33 trillion in total investments, are supported by a framework that assists asset owners and managers in implementing their commitments.[266]

C. Enforcement of Government Net Zero Targets

Although the forgoing enforcement mechanisms may not be available against governments, public entities' net zero commitments might be enforced in some countries through statutory, constitutional, or human rights litigation.

In the United States, separation-of-powers concerns and justiciability doctrines make it unlikely that a court would issue an order enforcing a broad net zero target. The *Juliana*[267] litigation, where plaintiffs sought to vindicate their alleged right to a "climate system capable of sustaining human life," suggests how a court might approach a net zero-based claim.[268] In

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264 *See id.* at 1449–57; *see also* Gilligan, *supra* note 261, at 186–87.

265 Press Release, Ceres, New Global Effort Launches for Investors to Achieve Net-Zero Portfolios in Line with the Paris Agreement Goals (Mar. 10, 2021).

266 *See* INST. INV. GROUP ON CLIMATE CHANGE, NET ZERO INVESTMENT FRAMEWORK IMPLEMENTATION GUIDE 5 (2021), https://perma.cc/7W4J-TLWD.

267 Juliana v. U.S., 947 F.3d 1159 (9th Cir. 2020).

268 *Id.* at 1164 (internal quotation omitted).

Juliana, the Ninth Circuit dismissed the plaintiffs' claims—rooted in due process and public trust doctrine—for lack of standing.[269] The court explained that only the political branches, not the courts, could redress the plaintiffs' injuries by requiring "the government to develop a plan to 'phase out fossil fuel emissions and draw down excess atmospheric CO_2.'"[270] Efforts to enforce a net zero target against the federal government would likely encounter similar judicial reluctance. Cases in Canada[271] and the United Kingdom[272] involving analogous claims have come out similarly.

Incorporating net zero targets into law may enhance prospects for enforcement in some countries. A prominent example of such legislation is the United Kingdom's Climate Change Act,[273] which establishes a goal of achieving net zero by 2050, requires the establishment of five-year carbon budgets, and mandates regular reporting of emissions and

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269 *See id.* at 1164–65 ("[T]he plaintiffs' impressive case for redress must be presented to the political branches of government.").

270 *Id.* at 1164–65.

271 *See* La Rose et al. v. Her Majesty the Queen, [2020] F.C. 1008, 23 (Can.) (dismissing claims that Canada's weak climate policy violated plaintiffs' constitutional rights as nonjusticiable and failing to state a reasonable cause of action).

272 *See* Plan B Earth & Others v. Secretary of State [2018] EWHC 1892 (Eng.), *appeal denied*, [2019] No. C1/2018/1750 (Eng.) (dismissing claims that the U.K. government had a public sector equality duty to limit global temperature rises by reducing emissions for failure to state a claim).

273 Climate Change Act 2008, c. 27 (UK).

budget implementation.[274] Similar legislation in Canada requires its environmental minister to set periodic carbon reduction targets (or "milestones") every five years and to establish a GHG emission reduction plan for achieving each target, with the objective of attaining net zero by 2050.[275] Aside from declaring a net zero target date, such legislation can establish frameworks that promote coordination, collaboration, transparency, and accountability.[276] Denmark's climate law, for instance, not only sets target dates for reducing and eliminating emissions but also requires the government to obtain parliamentary approval of its climate strategies each year.[277]

In some countries, rights-based or statute-based litigation may offer an avenue for enforcing governmental net zero targets or pathways even if the targets themselves are not

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274 *Id.* §§ 1, 4, 14, 16, 18.

275 Canadian Net-Zero Emissions Accountability Act, S.C. 2020, c C-12, §§ 6–10 (Can.).

276 *See* CANADIAN INSTITUTE FOR CLIMATE CHOICES, MARKING THE WAY: HOW LEGISLATING CLIMATE MILESTONES CLARIFIES PATHWAYS TO LONG TERM GOALS ix (2020), https://perma.cc/W2AK-2KWV (PDF). If a target is not met, the minister must explain why and describe measures being taken to address such failure. Canadian Net-Zero Emissions Accountability Act, § 16; *see also* David V. Wright, *Bill C-12,* Canadian Net-Zero Emissions Accountability Act*: A Preliminary Review,* ABLAWG (Nov. 23, 2020), https://perma.cc/67WF-US7X (describing the compliance mechanisms of Bill C-12).

277 Jocelyn Timperley, *The Law That Could Make Climate Change Illegal*, BBC FUTURE PLANET (July 7, 2020), https://perma.cc/SER4-939M.

enshrined in law. Germany's Federal Constitutional Court, for example, held in *Neubauer*[278] that the German federal government has a duty to develop a long-term climate strategy consistent with the Paris Agreement.[279] The government's failure to specify emissions reductions beyond 2030, the court explained, violated constitutional rights to "a future in accordance with human dignity" and to "an ecological minimum standard of living."[280] Although Germany had enacted a law detailing strategies for achieving a 55 percent reduction in emissions by 2030, the court noted that the law "irreversibly offload[ed] major emission reduction burdens onto periods after 2030."[281] The court ordered the government "at the very least [to] determine the size of the annual emission amounts to be set for periods after 2030 itself or impose more detailed requirements for their definition by the executive

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278 Bundesverfassungsgericht [BVerfG] [Federal Constitutional Court] Mar. 24, 2021, 1 BvR 2656/18, https://perma.cc/RDC8-C2UY (Ger.).

279 *See Constitutional Complaints Against the Federal Climate Change Act Partially Successful*, BUNDESVERFASSUNGSGERICHT (Apr. 29, 2021), https://perma.cc/Z6XA-ZZ2K (reporting the court's holding that "emissions amounts allowed until 2030 are incompatible with fundamental rights insofar as they lack sufficient specifications for further emission reductions from 2031 onwards"). Unofficial translation of full decision available at: Neubauer et al. v. Germany, https://perma.cc/RDC8-C2UY (PDF).

280 *Constitutional Complaints*, *supra* note 279.

281 *Id*.

authority . . . ."[282] In recognizing a duty to develop a long-term climate strategy consistent with the Paris Agreement, *Neubauer* could serve as a foundation for a procedural duty to develop not only a net zero target but also a detailed strategy for achieving such a target.[283]

In another rights-based decision, the Netherlands' Supreme Court in *Urgenda*[284] upheld a lower court mandate that the Netherlands adopt measures to reduce GHG emissions to 25 percent below 1990 levels by 2020.[285] At issue were European Convention on Human Rights provisions guaranteeing rights to life, private life, and family life.[286] The court

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[282] *Id.* In response to the decision, German officials have proposed to achieve net zero by 2045, reduce GHG emissions 88 percent by 2040, and boost Germany's 2030 emissions reduction target from 55 percent to 65 percent. David Rising & Frank Jordans, *Germany Aims for Net Zero Emissions by 2045, 5 Years Earlier*, AP NEWS (May 5, 2021), https://perma.cc/X8RP-J258.

[283] Another relevant decision in this regard is *Friends of the Environment v. Ireland.* Relying on a statute that required the preparation of a mitigation plan for achieving a climate resilient and environmentally sustainable economy by 2050, the Irish Supreme Court ordered the Irish government to write a more detailed plan than the one it had prepared. Friends of the Irish Environment v. The Government of Ireland & Others, [2020] IESC 49, para. 9.2 (Ir.).

[284] HR 20 december 2020, ECLI:NL:HR:2019:2007 (Netherlands/Stichting Urgenda) (Neth.).

[285] *Id.* para. 2.2.1.

[286] *See id.* para. 5.2.1–5.3.2.

interpreted these provisions in the context of climate change as obliging member states to do their part to reduce GHG emissions.[287] In light of the 25–40 percent range of emissions reductions expected of developed countries, the court found the 17 percent reduction provided for under existing law inadequate.[288] Rejecting the contention that a judicial mandate to reduce emissions by 25 percent impermissibly required the government to create legislation, the court explained that the government remained free to determine the specific measures it would adopt.[289] While *Urgenda* does not address long-term mitigation goals, its reasoning could support a substantive obligation to adopt adequate measures to achieve net zero goals.[290]

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[287] *See id.* para. 5.8, 6.1.

[288] *See id.* para. 7.5.1 (explaining that the Netherlands should reduce emissions by at least 25 percent).

[289] *See id.* para. 8.2.7.

[290] *Cf.* Complaint at 41–42, Městský soudu v Praze podáno ze dne 21.04.2021 (MS) [Filed with the Circuit Court in the City of Prague on Apr. 21, 2021] (Czech), https://perma.cc/DZ6X-NPQV; Complaint at Annex para. 29–32, Cláudia Duarte Agostinho & Others v. Portugal & 32 Other States, No. 39371/20 (Eur. Ct. H.R., Sept. 3, 2020), https://perma.cc/SJ5T-BFGH (complaint, filed with the European Court of Human Rights against thirty-three European countries, seeking an order that each defendant nation adopt mitigation measures reflecting a "fair share" of the global burden of mitigating climate change).

Decisions challenging governments' failure to implement climate plans or policies suggest a possible basis for compelling the implementation of net zero policies. In *Leghari*,[291] for example, Pakistan's Lahore High Court held that "the delay and lethargy of the State in implementing the [nation's climate change policy framework] offends the fundamental [constitutional] rights of the citizens."[292] The court ordered the government defendants to nominate a "climate change focal person" within each relevant ministry "to ensure the implementation of the Framework" and to establish a commission to assist the court in monitoring implementation.[293] Although the case focused primarily on enforcing climate adaptation rather than climate mitigation efforts, it hints that some courts may be willing to compel implementation of net zero policies.[294]

IV. NET ZERO AND THE RELATIONSHIP BETWEEN CARBON MITIGATION AND CARBON REMOVAL

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[291] Leghari v. Federation of Pakistan & Others, (2015) WP No. 25501/2015 (Lahore High Court) 6 (Pak.), https://perma.cc/H4RZ-W9QP.

[292] *Id.* at 6.

[293] *Id.* at 6–7.

[294] Similarly, in *Srestha v. Office of the Prime Minister*, the Nepal Supreme Court ordered the drafting and implementation of a law specifically addressing climate change mitigation and adaptation and in the meanwhile ordered adherence to existing climate change policy and adaptation plans. *See* Srestha v. Office of the Prime Minister, 074-WO-0283 (Dec. 25, 2018), 13 (Nepal), https://perma.cc/PXZ2-GWMV.

Net zero commitments, if carried out, could contribute significantly to meeting Paris's temperature goals. How governments and corporations actually implement net zero pledges will be critical in determining whether those goals will be met and what a carbon-stabilized world will look like. Although net zero implies that carbon emissions will be balanced out by carbon removed, an important question that most net zero pledges are yet to address is whether to set distinct targets for carbon mitigation and carbon removal. This Part explains that important differences between the two, along with the potential for carbon removal to undermine carbon mitigation efforts, warrant separate targets.

A. *Existing Policies Linking Carbon Mitigation and Carbon Removal*

Net zero pledges build on various policies that already link carbon mitigation and carbon removal. Such policies might be viewed as weak precedents against setting distinct carbon mitigation and removal goals within net zero targets. The Kyoto Protocol, the Paris Agreement's predecessor, calculated parties' compliance with emissions caps by including carbon removed from the atmosphere via land use change.[295] The Paris Agreement, in calling for "a balance between anthropogenic emissions by sources and removals by sinks," suggests that emissions reductions and carbon removal are interchangeable.[296] Furthermore, various

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[295] *See* United Nations Climate Change, Reporting and Accounting of LULUCF Activities Under the Kyoto Protocol, https://perma.cc/7B7F-6X8Y (stating that the net change in carbon and greenhouse emissions from land-use change "shall be used to meet the commitments referred to in" the Kyoto Protocol).

[296] Paris Agreement, *supra* note 18, art. 4.1.

carbon markets recognize the fungibility of emissions reductions and some types of carbon removal.

1. The Kyoto Protocol

The Kyoto Protocol, which required developed countries to limit their GHG emissions, effectively treated certain types of land-based carbon removal as equivalent to mitigation in determining whether countries met their emission targets.[297] Specifically, each developed country party calculated its emissions by including "greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990."[298] Subsequent decisions integrated additional types of land-based carbon removal—forest management, cropland management, grazing land management, revegetation, and wetlands drainage and rewetting—into these calculations.[299]

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[297] *See* Neil Craik & William C.G. Burns, *Climate Engineering Under the Paris Agreement*, 49 ENV'T L. REP. 11113, 11116 (2019) (explaining that improved land management and forestry are well-understood as part of existing management strategies).

[298] Kyoto Protocol to the United Nations Framework Convention on Climate Change, art. 3.3, Dec. 10, 1997, 2303 U.N.T.S. 162, U.N. Doc. FCCC/CP/1997/L,7/ADD.1, 37 I.L.M. 32.

[299] *See* M.J. MACE ET AL., *supra* note 62, at 17 (noting that decisions gave developed countries the option to include net emissions and removals from other designated land

2. The Paris Agreement

As explained above, the Paris Agreement incorporates the net zero concept in its call for "a balance between anthropogenic emissions by sources and removals by sinks."[300] Consistent with this language, the agreement urges parties "to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases . . . including forests."[301]

Indeed, much of the modeling underlying Paris's temperature goals assumes ambitious amounts of carbon removal.[302] The modeled scenarios analyzed pathways for achieving specific climate goals in a cost-effective manner using a combination of carbon

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management activities in calculating total emissions); Annex to Decision 16/CMP.1 Land Use, Land-Use Change and Forestry, U.N. Doc. FCCC/KP/CMP/2005/8, at 6 (Mar. 30, 2006), https://perma.cc/V3AP-G5MN (providing guidance on how signatories may counterbalance emissions)**;** Annex to Decision 2/CMP.7 Land Use, Land-Use Change and Forestry, U.N. Doc. FCCC/KP/CMP/2011/10/Add.1, at 13–14 (Mar. 15, 2012), https://perma.cc/56AZ-THEN (same)**.** To address concerns regarding the verifiability and permanence of land-based carbon removals, parties could rely on such removals to satisfy only part of their compliance obligations. *See* M.J. MACE ET AL., *supra* note 62, at 17 (detailing the carbon removal potential).

300 *See* Paris Agreement, *supra* note 18 and accompanying text.

301 *Id.* art. 5.1.

302 *See* Lin, *Carbon Dioxide Removal*, *supra* note 43, at 549 (characterizing the feasibility of carbon dioxide removal predicted by some models as "highly questionable").

removal and mitigation techniques.[303] Under these scenarios, achieving the 1.5°C goal will require large-scale carbon removal,[304] and even the 2°C goal assumes significant carbon removal unless mitigation efforts dramatically escalate.[305] Seven years after negotiation of the Paris Agreement, as many countries struggle to meet their already inadequate climate pledges,[306] even greater reliance on carbon removal will likely be necessary to achieve Paris's temperature goals.

Parties' initial NDCs focused primarily on emission reductions, with little mention of carbon removal except in conjunction with forest management.[307] However, carbon removal

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303 *See* Minx et al., *supra* note 37, at 2–3.

304 *See* IPCC, *supra* note 19, at 121–22.

305 *See* Minx et al., *supra* note 37, at 13 ("[M]any commentators . . . suggest a large-scale dependence on negative emissions for 2°C scenarios[.]"); ROYAL SOC'Y, *supra* note 37, at 13 ("Only very dramatic and rapid emissions reduction will allow the 2°C target to be met without" carbon removal technologies); *see also* Lin, *Carbon Dioxide Removal*, *supra* note 43, at 549.

306 *See* EMISSIONS GAP REPORT 2021, *supra* note 15, at xix–xx (noting that G20 members are not on track to meet either their original or revised NDCs); Sachs, *supra* note 164, at 892–93.

307 *See* M.J. MACE ET AL., *supra* note 62, at 26 (highlighting guidance for reporting emissions from harvesting wood products). One quarter of mitigation pledged in NDCs arises from improved forest management. *See* ROYAL SOC'Y, *supra* note 37, at 28 (citing examples of deforestation reduction goals in Brazil and Mexico).

activities are poised to play a more prominent role over time.[308] The NDCs are to be revised every five years, with each successive NDC "represent[ing] a progression" beyond parties' previous commitments.[309] Parties are also encouraged to prepare nonbinding "long-term low greenhouse gas emission development strategies" to guide the development of successive NDCs.[310] Although most strategies submitted to date rely exclusively on emissions reductions, an increasing number of them refer to forest management and other types of carbon removal.[311] For example, Japan's strategy highlights CCS and calls for further work on DACS and other carbon removal techniques.[312] Similarly, the United Kingdom's strategy

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[308] *See* Craik & Burns, *supra* note 297, at 11121 (contending that states may "integrat[e] some [carbon removal] technologies into their reduction commitments since removals of CO_2 are expressly contemplated as an element of mitigation" under the Paris Agreement).

[309] Paris Agreement, *supra* note 18, art. 4.3, 4.9.

[310] *Id.* art. 4.19; *see* Mafalda Duarte, *Marching Toward 2050: Purpose and Elements of Long-Term Low Greenhouse Gas Emission Development Strategies*, WORLD RES. INST., https://perma.cc/ZXF7-L575. The strategies are available at *Communication of Long-Term Strategies*, UNITED NATIONS CLIMATE CHANGE, https://perma.cc/9L66-2ER3.

[311] *See* M.J. MACE ET AL., *supra* note 62, at 26–27 (outlining current provisions).

[312] Government of Japan, The Long-Term Strategy Under the Paris Agreement, at 16, 26, 36, 79–81 (2019) (discussing Japan's efforts and strategy for carbon reduction).

advocates research, development, and incentives to "strengthen . . . understanding of [carbon removal] technologies and, where appropriate, move forward with deployment."[313]

3. Carbon Markets

Carbon markets that allow trading of carbon removal-based offsets offer perhaps the most prominent example of the equivalent treatment of carbon emissions reductions and carbon removals. Under cap-and-trade carbon markets, a regulator sets an overall cap on GHG emissions and allocates allowances representing a right to emit a defined quantity of GHGs.[314] States, companies, or other sources must surrender allowances reflecting the amount of GHGs emitted.[315] These entities can trade allowances with each other and thereby choose either to reduce their own emissions directly or to pay other entities to make equivalent emissions reductions on their behalf.[316] Under some regimes, sources also may meet their compliance obligations by relying on offsets generated by entities that voluntarily

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313 GOV. OF THE U.K., THE CLEAN GROWTH STRATEGY: LEADING THE WAY TO A LOW CARBON FUTURE 57 (2018); *see also* Geden & Schenuit, *supra* note 25, at 24–25 (highlighting that the UK is currently the leader in integrating carbon removal into climate policy).

314 *See* Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENV'T L. REV. 293, 298 (2008) (explaining the basics of cap and trade).

315 *Id.*

316 *Id.*

remove carbon from the atmosphere.[317] Offsets are available most commonly for forestry-related carbon removal[318] and less frequently for other carbon removal techniques.[319]

a. Forestry Offset Credits

California's cap and trade regime allows regulated entities to rely in part on offsets to meet their caps, including offsets from forestry projects.[320] A ceiling on entities' use of offsets tacitly recognizes that the offsets do not represent carbon benefits wholly equivalent to direct

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317 *See* ERIC MARLAND ET AL., UNDERSTANDING AND ANALYSIS: THE CALIFORNIA AIR RESOURCES BOARD FOREST OFFSET PROTOCOL 1 (Springer eds., 1st ed. 2017) (outlining California's carbon offset regime); van Kooten, *supra* note 43, at 84 (stating that "most governments and international negotiations consider emissions trading to be the main policy vehicle").

318 *See* Wytze van der Gaast et al., *The Contribution of Forest Carbon Credit Projects to Addressing the Climate Change Challenge*, 18 CLIMATE POL'Y 42, 43 (2018) (explaining that forestry-related carbon offsets have been promoted by public funds that assist governments in their forest management).

319 Various reports have advocated for the integration of carbon removal into carbon markets. *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 133; ROYAL SOC'Y, *supra* note 37, at 11.

320 *See* MARLAND ET AL., *supra* note 317, at 6 (indicating that 58 percent of all offset credits issued in California were related to forest projects).

carbon mitigation.[321] A specific protocol governs programs involving reforestation, improved forest management, and avoided conversion of forests to non-forest land use.[322] Carbon benefits must be additional, permanent, and verifiable.[323] To account for the risk of leakage—i.e., that projects' carbon benefits will be undermined by carbon releases elsewhere—offsets

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[321] From 2013 to 2020, use of offsets was restricted to 8 percent of an entity's overall GHG compliance obligations. CAL. CODE REGS. tit. 17, § 95854(b) (2011). Legislation extending California's cap and trade regime to 2030 similarly restricts offset use. CAL. HEALTH & SAFETY CODE § 38562(b)(2)(E), https://perma.cc/K6WY-599C (limiting offset use to 4 percent of an entity's compliance obligations from 2021 to 2025 and 6 percent from 2026 to 2030 and requiring that half the offsets come from projects that provide direct environmental benefits to California).

[322] *See* AIR RESOURCES BOARD, COMPLIANCE OFFSETS PROTOCOL: U.S. FOREST PROJECTS (2011), https://perma.cc/2LJL-248S; AIR RESOURCES BOARD, COMPLIANCE OFFSETS PROTOCOL: U.S. FOREST PROJECTS (2014), https://perma.cc/7FDR-D67B; AIR RESOURCES BOARD, COMPLIANCE OFFSETS PROTOCOL: U.S. FOREST PROJECTS (2015) [hereinafter 2015 COMPLIANCE OFFSETS PROTOCOL], https://perma.cc/D54S-82KM.

[323] 2015 COMPLIANCE OFFSETS PROTOCOL, *supra* note 322, at 25 (2015); *see* Tatyana Ruseva et al., *Additionality and Permanence Standards in California's Forest Offset Protocol: A Review of Project and Program Level Implications*, 198 J. ENV'T MGMT. 277, 279 (2017).

are discounted.[324] In addition, a fraction of offsets are set aside in a buffer account and retired if fires or other events result in unintended carbon release.[325] Although forestry projects have accounted for the majority of California's offset credits,[326] high transaction costs, complicated procedures, extensive commitment periods, and low and inconsistent carbon prices have discouraged participation.[327]

Australia has granted carbon offsets not only for forest carbon management but also for other specified land management activities. Under the country's Carbon Farming Initiative, landowners generated carbon credits through activities that sequestered carbon

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[324] For a critical view of whether CARB has adequately accounted for leakage, see Barbara Haya, Policy Brief: The California Air Resources Board's U.S. Forest Offset Protocol Underestimates Leakage (2019), https://perma.cc/D5G9-A8HY (PDF).

[325] 2015 COMPLIANCE OFFSETS PROTOCOL, *supra* note 322, at app. D; *see* Ruseva et al., *supra* note 323, at 280 (explaining the purpose and use of the buffer account).

[326] *See* Chaeri Kim & Thomas Daniels, *California's Success in the Socio-Ecological Practice of a Forest Carbon Offset Credit Option to Mitigate Greenhouse Gas Emissions*, 1 SOCIO-ECOLOGICAL PRACTICE RESEARCH 125, 131 (2019) (detailing the forests accounting for the credits).

[327] *See* MARLAND ET AL., *supra* note 317, at 53–54, 66 (discussing costs and other barriers); Nicolena vonHedemann et al., *Forest Policy and Management Approaches for Carbon Dioxide Removal*, 10 INTERFACE FOCUS 1, 10 (2020). The low price of carbon has been blamed for the negligible forestry projects undertaken in another domestic carbon market, the Regional Greenhouse Gas Initiative (RGGI). *Id.* at 10.

"in living biomass, dead organic matter[,] or soil," including afforestation, reforestation, and soil sequestration.[328] Initially, industry could use these credits to satisfy up to 5 percent of their carbon tax obligations.[329] Australia subsequently replaced its carbon tax with a voluntary program to subsidize carbon abatement.[330] Now, businesses that register carbon reduction or removal projects can earn carbon credits and then sell those credits to the

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[328] Megan C. Evans, *Effective Incentives for Reforestation: Lessons from Australia's Carbon Farming Policies*, 32 CURRENT OP. ENV'T SUSTAINABILITY 38, 39 (2018); Jonathan Verschuuren, *Towards a Regulatory Design for Reducing Emissions from Agriculture: Lessons from Australia's Carbon Farming Initiative*, 7 CLIMATE L. 1, 16 (2017).

[329] Ing-Marie Gren & Abenezer Zeleke Aklilu, *Policy Design for Forest Carbon Sequestration: A Review of the Literature*, 70 FOREST POL'Y & ECON. 128, 133 (2016); Verschuuren, *supra* note 328, at 15. Australia's 2011 Clean Energy Act, later repealed, provided for a carbon tax on industry for 2012–2015, followed by a cap-and-trade scheme to apply beginning July 2015. *Id.* at 14.

[330] *See* Evans, *supra* note 328, at 39.

government through a reverse auction.[331] Forest-based sequestration (especially conversion of agricultural land to forests) has accounted for most of the funded projects.[332]

At the international level, the Kyoto Protocol's Clean Development Mechanism (CDM) was expected to serve as an important carbon market for forest-based carbon removal.[333] Under this emissions trading scheme, emissions reduction projects and forest-related carbon removal projects in developing countries could generate carbon offsets, and developed

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[331] *See* COMMONWEALTH OF AUSTRALIA, THE EMISSIONS REDUCTION FUND—WHAT IT MEANS FOR YOU 7–8 (2019), https://perma.cc/7U6Z-47ZH (PDF). Critics have attacked the use of public money to pay for these projects and questioned their additionality and permanence, noting that some projects may be terminated after only 25 years. *See* Adam Morton, *Up in Smoke: What Did Taxpayers Get for the $2bn Emissions Fund?*, GUARDIAN (June 2, 2018), https://perma.cc/J3KN-UY38 (profiling potential issues with the program); Evans, *supra* note 328, at 41 (same).

[332] *See* Schenuit et al., *supra* note 83, at 10–11 (citing this method as the primary climate policy instrument in Australia); Courtney M. Regan et al., *The Influence of Crediting and Permanence Periods on Australian Forest-Based Carbon Offset Supply*, 97 LAND USE POL'Y 104800, at 2 (2020) (noting that "[f]orest-based sequestration methods accounted for approximately 81 percent of the total AUD $2.29 billion spent on all projects" at the date of the article's publication); Morton, *supra* note 331 (stating that "vegetation projects," including "regenerating degraded habitat, tree-planting and 'avoided deforestation'" are expected to deliver two-thirds of the effects of Australia's emissions reductions fund).

[333] *See* Lin, *supra* note 43, at 552.

countries could purchase these offsets in lieu of reducing their own emissions.[334] Though projected to be significant sources of credits, afforestation and reforestation projects ultimately constituted less than 1 percent of CDM projects.[335] The European Union refused to accept credits from CDM forestry projects in its Emissions Trading System, citing concerns about leakage, permanence, and accounting.[336] The long timescale associated with forestry projects and the temporary nature of any credits that might be granted also made forestry projects relatively unattractive.[337]

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[334] *See id.* at 553–57 (noting criticism of CDM's potential to reward actions that generate GHG credits but fail to make a positive environmental impact).

[335] *See* vonHedemann, *supra* note 327, at 4 (2020) (highlighting that those projects were 0.9 percent of over 7,000 CDM projects); ROSS W. GORTE & JONATHAN L. RAMSEUR, CONG. RSCH. SERV., RL34560, FOREST CARBON MARKETS: POTENTIAL AND DRAWBACKS 3 (2008) (citing that afforestation and reforestation have only accounted for 0.3 percent).

[336] *See* vonHedemann, *supra* note 327, at 4.

[337] *See id.* The Paris Agreement contains several potential tools for promoting forest-based carbon removal. Article 6 of the agreement allows parties to transfer or share emission reductions from reduced deforestation and to engage in trading of carbon credits under the yet-to-be defined successor to the CDM, the Sustainable Development Mechanism. Paris Agreement art. 6.1, 6.4; *see also* Honegger & Reiner, *supra* note 35, at 315–16 (noting importance of ensuring credible accounting, keeping transaction costs low, and facilitating financial transfers in any mechanism that incorporates carbon removal projects).

The limitations placed on recognizing carbon credits from forest management reflect a view that carbon removal by forests warrants encouragement but is not quite equivalent to carbon mitigation. At the same time, modest levels of participation in such projects suggests that additional incentives—and safeguards—may be necessary to encourage desired types of carbon removal.

b. Credits from Non-Forestry Carbon Removal Projects

The granting of carbon offsets for engineered carbon removal, such as the generous offsets for DACS available under amendments to California's Low Carbon Fuel Standard (LCFS), likewise suggests a degree of interchangeability between emissions reductions and carbon removal. Established in 2006, the LCFS aims to reduce the carbon intensity of transportation fuels sold in California.[338] When a distributor sells fuel having a greater carbon intensity than specified targets, it must obtain LCFS credits to compensate for the excess carbon.[339] Amendments to the statutory scheme now allow for the issuance of LCFS credits for the storage of carbon captured directly from the air,[340] provided that an operator

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338 *See* ALEX TOWNSEND & IAN HAVERCROFT, THE LCFS AND CCS PROTOCOL: AN OVERVIEW FOR POLICYMAKERS AND PROJECT DEVELOPERS 4 (2019).

339 *See id.* at 7 (adding that this rule applies to fuel providers who "produce, import, distribute, or sell transportation fuels in California").

340 CAL. CODE REGS. tit. 17, § 95490(a); TOWNSEND & HAVERCROFT, *supra* note 338, at 9. The revised LCFS also authorizes credits for the storage of carbon captured from

demonstrates a greater than 90 percent probability that at least 99 percent of the carbon will be stored for at least one hundred years.[341] Credits can be granted regardless of project location.[342]

The value of LCFS credits, which have averaged close to two hundred dollars per ton, could offer a powerful incentive for DACS projects worldwide.[343] Even though credit prices are projected to drop towards one hundred dollars per ton in the current decade,[344] they would remain an order of magnitude greater than the price of credits arising from forestry

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transportation fuel production processes, provided that the fuel is sold in California, and it allows fuels produced using carbon captured from the air to qualify as low carbon fuels so long as they are sold in California. *See* JOHN LARSEN ET AL., CAPTURING LEADERSHIP: POLICIES FOR THE US TO ADVANCE DIRECT AIR CAPTURE TECHNOLOGY 23 (2019) ("For every net ton of CO_2 removed from the atmosphere and permanently stored, [Direct Air Capture (DAC)] facilities receive LCFS credits.").

341 TOWNSEND & HAVERCROFT, *supra* note 338, at 10.

342 CAL. CODE REGS. tit. 17, § 95490(b)(3).

343 *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 53.

344 LARSEN ET AL., *supra* note 340, at 23.

projects.[345] The potential to combine LCFS credits with other incentives could make DACS projects especially attractive.[346]

One such incentive, available under Section 45Q of the Internal Revenue Code, is a tax credit of up to fifty dollars per ton for the permanent underground storage of at least 100,000 tons of CO_2 from the ambient air.[347] The 45Q credit was originally limited to CCS

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[345] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 53. Forestry offset credits trade in the range of thirteen to fifteen dollars per ton in California's carbon market. *See* Ryan Dezember, *Preserving Trees Becomes Big Business, Driven by Emissions Rules*, WALL ST. J. (Aug. 24, 2020, 5:42 AM), https://perma.cc/3WWR-S27L ("California credits changed hands at an average of $14.15 in 2019 and were up to $15 before the coronavirus lockdown drove them lower. They have lately traded for about $13.").

[346] *See* TOWNSEND & HAVERCROFT, *supra* note 338, at 20 ("In combination, LCFS credits and 45Q tax credits could provide CCS project developers in the US with a strong financial incentive to capture CO2 emissions and invest in CCS.").

[347] 26 U.S.C. § 45Q(a), (b), (d)(2)C), (e)(1). In addition, project construction must begin by January 1, 2026, in order to take advantage of the credit. *See* Consolidated Appropriations Act, 2021, H.R. 133, 116th Cong. § 133 (2020) (extending the carbon dioxide sequestration credit by two years).

projects at power plants and other GHG-generating facilities.[348] Congress expanded the tax credit to DACS in 2018, recognizing the value of carbon sequestration regardless of whether the carbon was captured from the air or from power plant exhaust.[349] Although the tax credit alone appears insufficient to incentivize DACS or the capture and storage of industrial emissions,[350] combining the tax credit with LCFS credits or other incentives could make DACS projects financially viable.[351]

B. *Comparing Mitigation and Carbon Removal*

Policies linking carbon mitigation and carbon removal—including the net zero concept—reflect the atmospheric equivalence of a ton of carbon emissions avoided and a ton

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348 *See* ANGELA C. JONES & MOLLY F. SHERLOCK, CONG. RSCH. SERV., IF11455, THE TAX CREDIT FOR CARBON SEQUESTRATION (SECTION 45Q) (2021) ("The tax credit for carbon oxide sequestration—often referred to using its IRC section, 45Q—is computed per metric ton of qualified carbon oxide captured and sequestered. (Before 2018, the tax credit was exclusively for CO2.)").

349 26 U.S.C. § 45Q(d).

350 *See* Carlos Anchondo, *Trump's CCS Rule: Details, Doubts and EPA Disputes,* ENERGYWIRE (June 1, 2020, 7:30 AM), https://perma.cc/8L37-RSKD; Iulia Gheorghiu, *IRS Clarifies Carbon Capture Tax Credit, But More Policies Needed to Drive Deployment, Analysts Say*, UTILITY DIVE (Jun. 1, 2020), https://perma.cc/DE3M-QX9H (stating that these new technologies are exciting but expensive).

351 *See* Gheorghiu, *supra* note 350 (stating that some have argued that the tax credit will better support carbon capturing technologies once they become commercial).

of carbon removed. Carbon mitigation and carbon removal nonetheless differ in important ways. Equivalent treatment of the two ignores differences in verifiability, permanence, feasibility, and risks. Ultimately, these differences and the potential for carbon removal to undermine carbon mitigation warrant the establishment of distinct goals within net zero targets.

1. The Argument for Equivalence

From a physical science perspective focused narrowly on atmospheric carbon concentrations, equivalent treatment of carbon mitigation and carbon removal is logical: "Removing CO_2 from the atmosphere and storing it has the same impact on the atmosphere climate as simultaneously preventing emission of an equal amount of CO_2."[352]

Distinctions commonly drawn between specific techniques of mitigation or removal sometimes may seem arbitrary.[353] Stopping deforestation typically qualifies as mitigation, whereas afforestation constitutes carbon removal.[354] Capturing and storing carbon from an industrial facility is characterized as mitigation, whereas capturing and storing carbon from the air is deemed carbon removal.[355] Categorically favoring mitigation over carbon removal

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352 NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 23.

353 *See* Gareth Davies, *An Emissions Commitment is a Plan for the Future: Developing and Using New NETs Should Be at the Heart of that Plan*, *in* DEBATING CLIMATE LAW (B. Mayer & A. Zahar eds., 2021).

354 *See id.* at 4.

355 *See id.* at 4–5.

may overlook the uncertainties and concerns associated with specific techniques.[356] For example, both the cultivation of bioenergy crops (often characterized as mitigation) and afforestation (a form of carbon removal) may displace other land uses and make intense demands on water and other resources.[357] Likewise, CCS—typically classified as mitigation—shares common challenges of cost and lack of infrastructure with DACS and BECCS, carbon removal techniques that incorporate CCS.[358] And just as efforts to reduce carbon emissions from electricity generation and industrial production in one place may be counterbalanced by the relocation of these activities elsewhere,[359] forest conservation at one location may shift deforestation to other locations.[360]

2. Differences

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356 *See id.* at 7.

357 *See* M.J. MACE ET AL., *supra* note 62, at 28.

358 *See id.* at 29.

359 *See id.* at 31 (stating that "appropriate regulations or safeguards will need to be put in place").

360 *See* G. Cornelis van Kooten & Craig M.T. Johnston, *The Economics of Forest Carbon Offsets*, 8 ANN. REV. RES. ECON. 227, 230 (2016) ("[B]ecause deforestation releases significant amounts of CO2 into the atmosphere, the preservation and conservation of forests—that is, preventing degradation, converting to other uses, or simply delaying harvest—have been proposed as eligible but controversial means to obtain carbon offset credits.").

Carbon removal and carbon mitigation nonetheless differ in important ways with respect to verifiability, permanence, readiness, and risks. Some of these differences apply only to specific techniques, but taken together, these differences warrant distinct treatment of carbon mitigation and carbon removal.

a. *Accounting/Verifiability*

Existing reporting mechanisms for fossil fuel extraction, imports, and sales can readily track CO_2 emissions from fossil fuel combustion and reductions in such emissions.[361] In contrast, quantifying carbon benefits from carbon removal generally poses greater difficulties.[362]

Carbon accounting for nature-based carbon removal is particularly challenging. As a general matter, carbon removal rates depend on complex flows between carbon reservoirs and change over time.[363] Uncertainties and heterogeneity in the amount of carbon removed have been a significant obstacle to incorporating forests into the climate regime.[364] Climate conditions, tree species, rates of decomposition, and soil quality all may affect carbon removal

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361 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 185 (evaluating the existing technologies).

362 *See* Guy Lomax et al., *Reframing the Policy Approach to Greenhouse Gas Removal Technologies*, 78 ENERGY POL'Y 125, 130 (2015) ("[P]ractical quantification of carbon stored in many [carbon removal] technologies is more difficult than quantification of carbon emitted by fossil fuel combustion.").

363 *See id.*

364 *See* van der Gaast et al., *supra* note 318, at 44.

rates.[365] Ongoing changes in land cover compound the uncertainty, as do climate change's effects on plant growth and natural disturbances.[366] Such uncertainties are especially large in developing countries, which tend to have limited measuring and monitoring capacity.[367]

Soil carbon sequestration also "is very challenging to quantify [and] has historically likely been overestimated because of sampling bias."[368] Changes in soil carbon are small relative to background carbon levels and often difficult to detect.[369] Land management approaches, soil types, and local climate affect carbon sequestration rates.[370] Experts nonetheless believe that soil carbon sequestration could be feasibly deployed, at least in parts

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365 *See* vonHedemann et al., *supra* note 327, at 11; Gren & Aklilu, *supra* note 329, at 129; van der Gaast et al., *supra* note 318, at 43 ("Forestry projects, with their relatively long time horizons, have long been considered relatively risky investments."); Barbara Haya et al., *Managing Uncertainty in Carbon Offsets: Insights from California's Standardized Approach*, 20 CLIMATE POL'Y 1112, 1122 (2020).

366 *See* ROYAL SOC'Y, *supra* note 37, at 28 (pointing out that "the land is simultaneously a source and sink of CO2, due to a combination of both natural and anthropogenic factors").

367 *See* MACE ET AL., *supra* note 62, at 29 (stating that developing countries tend to have limited measurement and monitoring capacities).

368 NCI, ACCELERATING NET-ZERO TARGET SETTING, *supra* note 2, at 4. Biochar raises similar concerns regarding measurement and verification. *See* Fuss et al., *supra* note 47, at 26.

369 *See* ROYAL SOC'Y, *supra* note 37, at 34.

370 *See id.* at 33.

of the United States, with remote monitoring and verification combined with measurements onsite.[371]

Monitoring and verification are relatively less difficult for geologically stored carbon, for which methods of tracking storage and detecting leakage are fairly well-developed.[372] DACS is unlikely to pose unmanageable accounting concerns.[373] Carbon accounting may prove more challenging for BECCS, as calculations of net carbon removal must account for induced land use change as well as variations in production, transport, conversion, and sequestration.[374] Relatively little is known about the verifiability of carbon stored via mineralization processes, though scientists suggest that measuring carbon storage for land-based enhanced weathering may be easier than for marine-based processes.[375]

b. *Impermanence*

Carbon mitigation and carbon removal must be permanent in order to effectively address climate change. Carbon mitigation results in avoided emissions, which pose no risk

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371 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 12.

372 *See id.* at 343–44.

373 *See id.* at 12.

374 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 185–86 (explaining that "the amount of net carbon removal largely depends on the specific pathway chosen"); *cf.* ROYAL SOC'Y, *supra* note 37, at 41.

375 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 12; ROYAL SOC'Y, *supra* note 37, at 51–52.

of escape.[376] In contrast, carbon removal techniques are subject to varying risks of carbon loss.[377] Carbon stored in soil or wetlands can escape upon disturbance.[378] Carbon stored in forests can be released by clearing, fire, or disease.[379] Weak land use governance in some countries may intensify worries about impermanence of nature-based carbon storage.[380]

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[376] *See* Kate Dooley & Sivan Kartha, *Land-based Negative Emissions: Risks for Climate Mitigation and Impacts on Sustainable Development*, 18 INT'L ENV'T. AGREEMENTS 79, 85 (2018).

[377] *See* Duncan P. McLaren et al., *Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions*, FRONTIERS IN CLIMATE, Nov. 2019, at 2 (differentiating between carbon mitigation and carbon removal).

[378] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 11–12 ("The terrestrial and coastal blue carbon options are reversible if the carbon sequestering practices are not maintained.").

[379] *See id.* To address impermanence concerns, carbon markets may withhold a fraction of offset credits in a buffer pool and nullify those credits if stored carbon is subsequently released. *See id.* at 11.

[380] *See* Duncan Brack & Richard King, *Managing Land-based CDR: BECCS, Forests and Carbon Sequestration*, 12 GLOB. POL'Y (SPECIAL ISSUE) 45, 49 (2021).

Impermanence is a lesser concern for BECCS, DACS, and land-based enhanced weathering.[381] Storage of carbon in geologic reservoirs, as in BECCS and DACS, would present a relatively low risk of significant leakage if properly designed and implemented, and any leakage theoretically should be detectable and remediable.[382] Although marine enhanced weathering would store carbon in a dissolved and potentially impermanent form, enhanced weathering on land would store carbon in a relatively permanent solid state.[383]

The need to store carbon for centuries or longer further complicates the enforceability of carbon storage obligations.[384] In the mitigation context, an entity that emits excessive GHGs can be penalized and required to make up for its excess emissions. Enforcing an

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[381] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 36, at 12; Fuss et al., *supra* note 47, at 14 ("In principle, once the CO2 removed from the atmosphere via BECCS is geologically stored, it is one of the NET options that is less vulnerable to reversal.").

[382] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 343–44 (highlighting the advantages of BECCS and DACS); M.J. MACE ET AL., *supra* note 62, at 30.

[383] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 12 ("CO_2 that is geologically sequestered can leak from saline aquifers but at rates low and straightforward enough to remediate."); Fuss et al., *supra* note 47, at 23 ("Hence these methods are connected and other land-based NETs could rely on EW to create the optimal soil and nutrient supply conditions.").

[384] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 42 (concluding that "carbon needs to be stored, on average, for millennia" because of its long residence time in the atmosphere and oceans).

entity's commitment to store emissions for centuries is trickier. Possible mechanisms to incentivize follow through on such commitments include withholding carbon credits or awarding them over time, but these mechanisms would reduce the value of credits and the attractiveness of carbon storage projects.[387]

c. *Technological Maturity and Feasibility*

Although some carbon mitigation technologies, such as energy storage and net zero carbon fuels, require further research and development,[388] many carbon mitigation options, including renewable energy generation and energy efficient technologies, are technologically mature and economically feasible.[389]

Carbon removal technologies also reflect a range of maturities and costs. However, scenarios for achieving Paris's temperature goals rely most heavily on carbon removal technologies that are less mature and involve greater uncertainties.[390] Relatively cheap techniques that are already being deployed, such as afforestation and soil carbon

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387 *See* NCI, ACCELERATING NET-ZERO TARGET SETTING, *supra* note 2, at 4. Indeed, contracts to create forest carbon offsets not only involve long-term commitments that are difficult to enforce but also are subject to principal-agent problems that can undermine the integrity of the offsets. *See* van Kooten, *supra* note 43, at 85–86.

388 *See* NAS, ACCELERATING DECARBONIZATION, *supra* note 27, at 57–58.

389 *Supra* notes 75–79 and accompanying text.

390 *See* Dooley & Kartha, *supra* note 376, at 82.

sequestration, offer only limited carbon storage capacity.[391] Carbon removal techniques that promise greater storage potential—BECCS and DACS—are more expensive and less mature, featuring in a small handful of demonstration projects.[392] BECCS has yet to achieve commercial viability,[393] and DACS has "arriv[ed] at the 'valley of death,' where new technologies often fail to commercialize due to lack of investment."[394] Expanded government

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[391] *See* Minx et al., *supra* note 37, at 17 ("NETs are, in principle, feasible at variable costs and with at least partially proven technology but not at unlimited scale, and often with high uncertainties on impact."); Dooley & Kartha, *supra* note 376, at 84 (differentiating between various carbon removal techniques).

[392] *See* Minx et al., *supra* note 37, at 17 (emphasizing the importance of discussing a "variety of technologies contributing potentially at more modest scales").

[393] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 149 ("Biomass-fueled power generation is commercially deployed across the United States and the world, although no biomass power plants are coupled with carbon capture and sequestration."); *cf. id.* at 8 (concluding that BECCS is "ready for large-scale deployment" under the assumption that geological sequestration is ready for large-scale deployment).

[394] LARSEN ET AL., *supra* note 340, at 20.

funding and policy support is necessary to enable commercialization and to stimulate demand for these technologies.[395]

Relatedly, the costs of carbon removal vary widely among techniques and are subject to change and uncertainty. Land-based carbon removal is generally less expensive, but costs vary depending on practice and region.[396] DACS, which can currently remove carbon at an estimated cost of $600 per ton, is not yet economically feasible.[397] However, some estimates project that costs could fall below $150 or one hundred dollars per ton with further development.[398] BECCS' costs are partially offset by the production of electricity, but the

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[395] *See id.* at 5–6, 20–21 (stating that federal action is needed to "push and pull DAC into the marketplace"); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 232–46 (listing barriers that need to be overcome for an effective assessment and deployment of direct air capture technology).

[396] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 120 ("The direct costs of establishing new forests and performing management activities in different regions are well known based on experience, and several studies have revealed how landowners would respond to various carbon price levels.").

[397] *Id.* at 125.

[398] *See* FRIEDMANN ET AL., *supra* note 13, at 22; Piotrowski & Langley, *supra* note 49, at 11–12 (citing NAS study); *see also* LARSEN ET AL., *supra* note 340, at 20 (estimating a levelized cost of $124 to $325 per metric ton of CO_2 removed from the atmosphere for the first state-of-the-art, megaton scale DAC plant, plus $18 per metric ton of CO_2 stored).

relative inefficiency of bioenergy facilities leaves these facilities at a marked cost disadvantage to other sources of electric power.[399]

d. Risks

Different techniques of carbon mitigation and carbon removal involve a range of drawbacks. However, greater uncertainty may surround the effects and risks of carbon removal technologies because they are generally less developed. The following discussion sketches out some of the more prominent concerns associated with carbon removal techniques.[400]

BECCS and land-based carbon removal techniques require significant amounts of land and could harm the livelihoods, food production, and biodiversity of local

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[399] *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 163 ("The primary challenge for biomass electrical power with carbon capture and sequestration is the low efficiency (typically less than 25 percent) of biomass power plants.").

[400] Note that some carbon removal technologies may offer co-benefits. BECCS produces energy or biofuels. *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 43 (explaining that a potential co-benefit of creating billions of tons of negative CO_2 emissions includes "electricity generation or biofuel production for BECCS"). Soil carbon sequestration, afforestation, biochar, and terrestrial enhanced weathering can improve soil quality. *See id.* at 123; Fuss et al., *supra* note 47, at 33 (noting the varying costs of different technologies).

communities.[401] This is of particular concern where land is converted to a new use.[402] Forestry activities and cultivation of bioenergy crops could increase competition for land, water, and fertilizer while exacerbating polluted runoff and other ecological impacts.[403] Increased forest cover also could contribute to further warming by reducing the reflection of solar radiation.[404]

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401 *See* IPCC, *supra* note 19, at 125 (highlighting the drawbacks of BECCS and other carbon removal techniques); Dooley & Kartha, *supra* note 376, at 84–85 (pointing out that large-scale deployment of NETs likely involves less than desirable ecological and social impacts).

402 *See* Fuss et al., *supra* note 47, at 13 ("Climate effects belong to the categories of direct land use change, indirect land use change, and albedo effects. Land use change emissions include those from change in previous use, such as deforestation, and changes in global land use induced by economic markets.").

403 *See id.* at 13, 16 (listing the negative impacts of forestry activities); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 165–67 ("The area of land required per unit mass of carbon removed from the atmosphere is particularly important for BECCS, leading to different potential impacts regarding land-use change, land conservation (e.g., nutrient availability), and biodiversity.").

404 *See* Fuss et al., *supra* note 47, at 16 (stating the biophysical, social, and economic side effects); Geden & Schenuit, *supra* note 25, at 10 (identifying "reduced reflection of solar radiation (albedo) in forest areas at northern latitudes" as a side effect of afforestation).

Compared to other types of carbon removal, DACS has a smaller physical footprint and offers greater geographical flexibility.[405] Air capture facilities in theory could be located anywhere, but energy, infrastructure, and water needs will influence their location.[406] DACS' large energy requirements are a major factor contributing to its high costs.[407] In addition, the geological carbon storage involved in DACS and BECCS may trigger risks of groundwater contamination, seismic activity, and leaks from overpressurization.[408]

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405 *See* Christoph Beuttler et al., *The Role of Direct Air Capture in Mitigation of Anthropogenic Greenhouse Gas Emissions*, FRONTIERS IN CLIMATE, Nov. 2019, at 4 (reporting estimate by Climeworks, a leading DACS developer, that removing one gigaton of CO_2 would require 2000 km2 of land, including land required for renewable energy production).

406 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 224 ("Direct air capture systems have significantly fewer land requirements than do afforestation/reforestation and BECCS approaches, and because they do not require arable land their impacts on biodiversity would be much smaller.").

407 *See* Geden & Schenuit, *supra* note 25, at 11 ("The potential of this method is limited by the large amounts of energy it requires."); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 365 (providing a table with costs).

408 *See* Fuss et al., *supra* note 47, at 14, 19 (highlighting global sequestration potential and costs); NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 337–38, 346 (explaining that induced seismic events have increased over the past five years "in regions with historically low rates of seismicity").

Enhanced weathering is surrounded by scientific, economic, and environmental unknowns.[409] Extracting and transporting minerals would impact the environment, and applying them could alter soil or ocean chemistry.[410] In some contexts, mineral application might yield co-benefits of improved soil quality or reduced ocean acidification.[411] In situ carbon mineralization (where carbon would be immobilized through subsurface reactions) might avoid some adverse impacts but the technique at this point remains "largely speculative" and might cause water contamination or increased seismicity.[412]

Just as some mitigation measures may be more acceptable to the public than others, different types of carbon removal will face varying levels of public acceptance.[413] Techniques that involve modifications to existing practices, such as improved forest management or soil

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409 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 8 ("carbon mineralization is currently constrained by many scientific unknowns, as well as uncertainty about environmental impacts and likely cost").

410 *See* Fuss et al., *supra* note 47, at 22 (pointing out side effects associated with extraction and transportation of minerals); IPCC, *supra* note 19, at 345–46 (explaining that ocean chemistry includes oxygen content and ocean acidification).

411 *See* Geden & Schenuit, *supra* note 25, at 11 (noting that mineral application "could contribute to improving soil quality" and "could counteract increasing [ocean] acidification").

412 NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 273, 302–03.

413 *See* Gregory F. Nemet et al., *Negative Emissions—Part 3: Innovation and Upscaling*, ENV'T. RSCH. LETTERS 063003, May 2018, at 8 ("While often treated as a separate issue, public acceptance of new technologies is crucial to their widespread adoption.").

carbon sequestration, may encounter less public opposition.[414] In contrast, techniques requiring land conversion could encounter resistance because of effects on land tenure, local livelihoods, food security, and gender equity.[415] Furthermore, concerns surrounding risks of geological storage could drive public opposition to DACS or BECCS projects.[416]

3. Mitigation Deterrence

Net zero strategies that fail to distinguish carbon removal and carbon mitigation assume their equivalence. Carbon markets that award credits equally for carbon removal and carbon mitigation rest on the same assumption. However, policymaking based on that assumption can undermine mitigation efforts.[417] In the course of implementing net zero, the danger, or moral hazard, is that key actors might substitute carbon removal for carbon mitigation.[418]

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414 *See id.*

415 See Holly Jean Buck, Rapid Scale-Up of Negative Emissions Technologies: Social Barriers and Social Implications, 139 CLIMATIC CHANGE 155, 159–65 (2016).

416 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 347.

417 *See* Kevin Anderson & Glen Peters, *The Trouble with Negative Emissions*, 354 SCIENCE 182, 183 (2016) (pointing out that negative-emission technologies exist at different levels of development); Geden, Peters & Scott, *supra* note 9, at 490 (explaining how the EU has been dealing with implementation of net zero policy).

418 *See* McLaren et al., *supra* note 377, at 1–2; Alexandre C. Köberle, *The Value of BECCS in IAMs: A Review*, CURRENT SUSTAINABLE/RENEWABLE ENERGY REP., Dec. 2019, at 107, 108.

Such substitution may be problematic if: (1) carbon removed is not equivalent to carbon mitigated; (2) substitution shifts the burden of climate action to different people or future generations; or (3) both carbon removal and carbon mitigation are essential. Each of these conditions is a cause for serious concern.

a. Non-Equivalence

Substituting carbon removal for emissions reductions could promote a more cost-effective response to climate change.[422] Under cap-and-trade regimes allowing for the direct interchangeability of carbon mitigated and carbon removed, entities could simply choose between reducing emissions directly or purchasing carbon credits generated by mitigation or carbon removal activities.[423] Regulated entities would have an economic incentive to choose the cheapest option and, if carbon mitigated and carbon removed were fungible, the same social benefit of limiting atmospheric carbon could be achieved at a lower cost.

Thus far, however, the cap-and-trade regimes that incorporate carbon removal generally have adopted conditions that acknowledge fundamental differences between carbon removal and mitigation. California established a ceiling on entities' ability to rely on offsets—including forestry offsets—to satisfy their compliance obligations. Australia's Carbon Farming Initiative capped industry's ability to rely on sequestered carbon to satisfy carbon tax requirements. And the European Union's refusal to accept carbon credits from CDM

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422 *See* Köberle, *supra* note 418, at 107.

423 *See* Gren, *supra* note 329, at 128.

forestry projects reflects skepticism regarding whether these credits represent carbon benefits equivalent to those generated by emissions reductions.[424]

One fundamental difference between carbon mitigation and carbon removal involves lost opportunity: "emissions reductions foregone in the present cannot be substituted in the global cumulative carbon budget by future emissions reductions."[425] In other words, a decision to emit carbon today is not reversible, although it can be countered by increasing reliance on carbon removal.[426] Another important distinction involves permanence: avoided emissions pose no risk of escape, whereas carbon removal poses varying risks of carbon loss, depending on the specific technique.[427] Moreover, carbon mitigation technologies generally

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[424] *See Use of International Credits*, EUR. COMM'N, https://perma.cc/PU4Z-DAP2 (precluding use of Clean Development Mechanism credits from afforestation or reforestation activities); *see also* Wilfried Rickels et al., *The Future of (Negative) Emissions Trading in the European Union* 9 (Kiel Inst. For the World Econ., Working Paper No. 2164, 2020) (citing Article 12(3a) of the ETS Directive). EU emissions trading rules do provide that emitting facilities need not surrender emission allowances for carbon emissions that are captured and stored. *Id.*

[425] McLaren, *supra* note 377, at 2.

[426] *Id*.

[427] *See supra* Part IV.B.2.

are more mature and involve less uncertainty than carbon removal techniques.[428] Those carbon removal techniques that are mature—afforestation and soil carbon sequestration—are subject to the greatest risk of carbon loss.[429] And those techniques that promise greater permanence—DACS and BECCS—are less mature.[430] When technological maturity and storage permanence are both considered, carbon mitigation techniques are preferable to carbon removal.[431]

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[428] *See* James Temple, *Carbon Removal Hype is Becoming a Dangerous Distraction*, MIT TECH. REV. (July 8, 2021), https://perma.cc/7554-YYLA (explaining that there is significant uncertainty about the viability and effectiveness of large-scale carbon removal strategies and technologies).

[429] *See* Dooley, *supra* note 376, at 85 ("Negative emissions options that rely on sequestering carbon into the terrestrial biosphere inherently entail a risk that those carbon stocks will be re-released to the atmosphere.").

[430] *See* Duncan Brack & Richard King, *Managing Land-based CDR: BECCS, Forests and Carbon Sequestration*, 12 GLOB. POL'Y 45, 47–50 (2020) (explaining that "BECCS remains a fledgling technology" while nature-based carbon removal techniques "can be deployed in the near term, at low cost, and are attainable from approaches that are already available, rather than being reliant on largely unproven technologies").

[431] *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 14 ("There are also ongoing risks of reversals and losses from carbon stored in land-based and geologic pools that could negate the climate benefit of carbon removals.").

Substitution of carbon removal for carbon mitigation also raises less obvious but equally important systemic concerns. Namely, such substitution might "delay[] transformative changes, lock[] in fossil fuel use, maintain[] the political power of fossil-heavy interests, and thus institutionaliz[e] the circumstances in which accelerated emissions cuts continue to be politically and economically expensive."[432] Carbon mitigation efforts today might facilitate future mitigation by building economies of scale and reducing marginal costs, whereas carbon removal might prevent or delay these benefits.[433]

b. Burden Shifting

A further danger of substituting carbon removal for carbon mitigation is the potential to shift the burdens of climate action—and risks of inaction—to vulnerable peoples or future generations. In climate change negotiations, developing countries have long resented being asked to preserve tropical forests in order to make up for developed countries' carbon

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[432] *See* McLaren, *supra* note 377, at 4; *see* Habiba Ahut Daggash & Niall Mac Dowell, *Higher Carbon Prices on Emissions Alone Will Not Deliver the Paris Agreement*, 3 JOULE 2120, 2132 (2019) (reporting modeling results indicating that early carbon removal may prolong reliance on fossil fuel-fired power plants).

[433] *See* Kenneth Gillingham & James H. Stock, *The Cost of Reducing Greenhouse Gas Emissions,* 32 J. OF ECON. PERSPS. 53, 63 (2018); Tabea Dorndorf et al., *Carbon Removal Experts Support Splitting "Net Zero" Into Twin Targets*, CLIMATE HOME NEWS (Nov. 5, 2021, 5:04 PM), https://perma.cc/P4EW-PJX7.

emissions.[434] Similar concerns that the Global South might bear disproportionate burdens surround the net zero concept.[435] In particular, carbon removal activities might impact food production, land use, biodiversity, and local livelihoods in these countries.[436] Moreover, should carbon removal efforts fall short, disadvantaged communities and the Global South will suffer the most severe climate consequences.[437]

Substituting carbon removal for carbon mitigation also may shift the timeframe in which climate action occurs. Carbon removal via afforestation and other nature-based techniques occurs over decades.[439] Land conversion activities, such as forest or habitat destruction, can generate an initial carbon debt and delay carbon removal benefits.[440] More

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[434] *See* Peter Healey et al., *Governing Net Zero Carbon Removals to Avoid Entrenching Inequities*, FRONTIERS IN CLIMATE, May 2021, at 38 ("CDRs are seen as the rich country escape route from assuming a historically fair share of gross emissions reductions. . . . [I]n the developing world, unconditionally fungible 'net zero' emission framings need to be replaced or circumscribed so as to address and mitigate such perceptions.").

[435] *See* Megan Darby, *Net Zero: The Story of the Target That Will Shape Our Future*, CLIMATE HOME NEWS (Sept. 16, 2019, 5:30 AM), https://perma.cc/BSB3-AYRL.

[436] *See* Dooley, *supra* note 376, at 92.

[437] *See* Anderson, *supra* note 417, at 183.

[439] *See* Rene Cho, *Net Zero Pledges: Can They Get Us Where We Need to Go?*, COLUM. CLIMATE SCH. (Dec. 16, 2021), https://perma.cc/5KEX-ECFF.

[440] *See* Mathilde Fajardy et al., *Negative Emissions: Priorities for Research and Policy Design*, FRONTIERS IN CLIMATE, Oct. 2019, at 3.

troublingly, carbon removal is sometimes framed as a tool to compensate in the future for present-day carbon emissions.[441] The application of discount rates in economic modeling can make future carbon removal seem more attractive than deep decarbonization today.[442] Yet forgoing emissions reductions now in favor of removing carbon later shifts responsibility for addressing the climate crisis to future generations.[443] It also transfers to future generations the risks that such technologies might fail or have unacceptable costs.[444] If these technologies prove infeasible or ineffective, there is no backstop alternative, no way to undo emissions already released.[445] The failure of carbon removal techniques to live up to expectations could

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441 *See* Dooley, *supra* note 376, at 81.

442 *See* Anderson, *supra* note 417, at 183.

443 Köberle, *supra* note 418, at 109. This point is underscored by the pivotal role of the discount rate used in Integrated Assessment Modeling scenarios: carbon removal is projected to assume an increasingly significant role as modelers apply a higher discount rate. *Id.* In other words, the application of a high discount rate can make future investments in carbon removal can appear unrealistically cheap in comparison to present-day mitigation. *Id.*

444 *See* Henry Shue, *Climate Dreaming: Negative Emissions, Risk Transfer, and Irreversibility*, 8 J. OF HUM. RTS. & ENV'T, 203, 208 (2017)

> [I]t is unjust to create a gamble in which, if it goes badly, the losers are people who are totally vulnerable to us, the poorer people of the future whose food supply we are gambling with, and, if it goes well, the winners are ourselves, the well-off of the present who might otherwise invest more heavily in ambitious mitigation now.

Dooley, *supra* note 376, at 82.

445 *See* Dooley, *supra* note 376, at 81.

leave humanity "stranded with an insufficiently transformed energy economy and a carbon debt that cannot be repaid." [446]

c. Both Essential

Indeed, not only might carbon removal be framed as a substitute for emissions reductions, but it might actually displace or deter mitigation efforts.[447] Such deterrence would harm the prospects of achieving Paris's climate goals. Achieving those goals requires *both* drastic reductions in emissions *and* a dramatic ramp-up of carbon removal.[449] As a National Academy of Sciences committee concluded, both a "massive deployment of low--carbon technologies" to reduce energy-related carbon emissions, as well as a rapid scale-up of carbon removal technologies that assumes uncertain research breakthroughs, are necessary.[450] Substituting carbon removal for carbon reduction does little good if both are essential.[451]

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446 *Id.* at 95.

447 *See* McLaren, *supra* note 377, at 1–2.

449 *See* NAS, NEGATIVE EMISSIONS TECHNOLOGIES, *supra* note 35, at 1, 9.

450 *See id.* at 1, 9; *see also* Honegger, *supra* note 35, at 308 (characterizing the scale of carbon removal necessary as "mindboggling"); Beuttler, *supra* note 405, at 1 (noting that vast majority of modeling pathways for achieving 2°C goal rely on large-scale carbon removal as well as mitigation).

451 *See* McLaren, *supra* note 377, at 1 ("[S]ubstituting negative emissions for emissions reduction could be harmful in itself. . . . It is crucial to ensure that negative emissions are delivered *in addition to* rapid emissions reduction.").

C. *Net Zero Pledges Should Incorporate Distinct Targets for Carbon Mitigation and Carbon Removal*

In light of important differences between carbon mitigation and carbon removal and the danger of mitigation deterrence, net zero policies should distinguish between carbon mitigation and carbon removal.[452] Indeed, just as net zero goals may be adopted internationally, nationally, sub-nationally, or by a single organization, distinct targets for carbon removal and emission reductions should be adopted at different levels as well.[453]

Net zero goals potentially obscure reliance on carbon removal and promote a narrow focus on costs.[454] All other things being equal, the economically rational way to implement a net zero commitment is to choose the most cost-effective option—i.e., the combination of carbon mitigation and carbon removal that fulfills that commitment at the lowest cost.[455] Various nations and companies have expressed an intent to achieve net zero by relying on forestry and other land-based carbon removal approaches, notwithstanding concerns of verifiability and impermanence.[456] This development is unsurprising, as the enhancement of natural carbon sinks typically has been viewed as a cheap source of carbon credits.[457] Yet net zero commitments that rely on DACS and BECCS raise concerns as well should these less

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452 *See id.* at 2.

453 *See id.*

454 *See* Dorndorf, *supra* note 433.

455 *See* Cho, *supra* note 439.

456 *See* Temple, *supra* note 428.

457 *See* Gren, *supra* note 329, at 128.

mature techniques fail to develop as anticipated.[458] The uncertain and changing nature of carbon removal costs further complicates calculations regarding the optimal blend of emissions mitigation and carbon removal.

1. Distinct Targets within Net Zero Pledges

As an initial matter, net zero targets—whether set by nations, corporations, or other entities—should include distinct targets for emissions reduction and carbon removal.[460] Clearly distinguishing the two can "safeguard the primacy of conventional mitigation measures and . . . communicate them visibly," thereby reducing the danger that the prospect of *future* carbon removal might undermine present mitigation.[461] Climate policy should strive

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458 *See* Levin et al., *Designing and Communicating*, *supra* note 4, at 14 (noting a "large degree of uncertainty about the scale and availability of future carbon removals from both land-based carbon sinks and emerging carbon-removal technologies").

460 This recommendation goes beyond other approaches that focus on distinct national or international targets, *e.g.*, Geden, *supra* note 25, or that call for a sector-based approach, *e.g.*, Yoichi Kaya et al., *Toward Net Zero CO_2 Emissions without Relying on Massive Carbon Dioxide Removal*, 14 SUSTAINABILITY SCI. 1739 (2019).

461 *See* Geden, *supra* note 25, at 6, 32; Levin et al., *Designing and Communicating*, *supra* note 4, at 3 ("Distinct targets provide a clear road map for decarbonization, scaling carbon removals, and achieving net-zero or net-negative emissions.").

to address climate change through ongoing action rather than shifting the burden of responding to future generations.[462]

Distinct targets would also limit the temptation to rely on *present-day* carbon removal to substitute for emissions reductions.[463] Some reliance on carbon removal to achieve net zero goals is inevitable because certain GHG emissions will be too difficult to eliminate.[464] However, the urgency of the climate crisis points toward minimizing tradeoffs of carbon mitigation against carbon removal.[465] Both mitigation and carbon removal are essential, and setting distinct targets for each limits the risk that success in one area would weaken efforts

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462 *See supra* note 444 and accompanying text.

463 *See* Rickels, *supra* note 424, at 11 (recommending against fully integrating carbon removal into emissions trading systems because it would favor the use of low-cost techniques).

464 *See* Healey, supra note 434, at 2 ("The IPCC 1.5° Report makes clear that offsetting residual emissions is one role of CDR[.]").

465 *See* Geden, *supra* note 25, at 7 ("[T]he *conventional* mitigation approach, which is aimed at avoiding emissions, has lost nothing of its urgency—quite the contrary. However, to achieve the global climate targets adopted by the UNFCCC, *unconventional* mitigation methods involving the deliberate removal of CO_2 from the atmosphere must also be used.").

in the other.[466] Unexpected progress on carbon removal could even enable net zero emissions—or even net negative emissions—to be achieved earlier than planned.[467]

Setting distinct targets for mitigation and carbon removal also can counter the tendency for market and regulatory uncertainty to undermine investment in projects or technologies with long planning horizons.[468] DACS and BECCS offer greater removal potential and permanence than other carbon removal techniques but are not yet cost

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[466] *See* Cho, *supra* note 439 (critiquing net-zero pledges as potentially meaningless, because the pledges necessarily depend on carbon offsets, including credits and nature-based removal, which allow companies to avoid the 'hard work' of mitigation).

[467] *See* Geden, *supra* note 25, at 6 ("[B]reak throughs in CO_2 removal methods would not lead to a decrease in emission reductions, but to *net zero* or *net negative emissions* being achieved earlier."); *cf.* Geden, *supra* note 9, at 492.

[468] *See* Elkind, *supra* note 49, at 11 ("Uncertainty about the state's long-term vision for engineered carbon removal can create lackluster project investment, especially for projects with long planning horizons that need certainty for years, if not decades, into the future.").

competitive.[469] Specific targets for DACS or BECCS—in addition to targets for overall carbon removal—can encourage investment to drive down costs and address potential risks.[470]

Setting distinct targets for mitigation and carbon removal has a historical precedent in EU climate policy.[471] Under EU policy from 2013 to 2020, negative emissions from land use changes were reported separately and were not counted towards the target of reducing

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[469] *See* Siddartha Ramakanth Keshavadasu, *Why We Must Ponder on Carbon Capture Technology to Reduce GHG Emissions*, DOWN TO EARTH (Oct. 18, 2021), https://perma.cc/7B65-53P2 (stating that carbon capture and storage is one of the most effective ways of reducing carbon in the atmosphere, but the current cost is approximately $900–$1,000 per ton).

[470] *See* Lars Zetterberg et al., *Incentivizing BECCS—A Swedish Case Study*, FRONTIERS IN CLIMATE, Aug. 2021, at 1, 6 ("Long-term agreements in which the government undertakes to buy a large volume of negative emissions from one or more suppliers through auctions have the possible advantage that the price can be pressed downwards.").

[471] *See* The European Parliament and of the Council Decision No. 529/2013/EU of 21 May 2013, art. 1, 2003 O.J. (L 165) 80 (describing accounting rules established by decision "as a first step toward the inclusion of those activities in the Union's emission reduction commitment, when appropriate").

emissions 20 percent by 2020.[472] Between 2021 and 2030, net carbon removals from the LULUCF (land use, land use-changes, and forests) sector may be counted only in limited quantities toward emission reduction targets.[473] In addition, a separate regulation establishes a specific target for the LULUCF sector and requires member states to ensure that LULUCF emissions do not exceed removals.[474] EU reluctance to fully integrate LULUCF

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[472] *Id*; *see* Annalisa Savaresi et al., *Making Sense of the LULUCF Regulation: Much Ado About Nothing?*, 29 REV. EUROPEAN, COMPAR. & INT'L ENV'T L. 212, 212–13 (2020) (explaining that LULUCF activities were excluded because they have been viewed as difficult to regulate and to measure).

[473] *See* The European Parliament and of the Council Regulation No. 2018/842 of 9 July 2018, art. 7, 2018 O.J. (L 156) 26 (explaining what kind of accounting categories may be taken into account for compliance when a Member State's emissions exceed allocation for the year). Targeted reductions would reduce energy and industrial emissions by 30 percent and overall emissions by 40 percent. *Id.* at art. 2. The role of LULUCF is likely to grow with the E.U. slated to reduce its emissions even further by 2030. Savaresi, *supra* note 472, at 218–19.

[474] *See* The European Parliament and of the Council Regulation No. 2018/841 of 30 May 2018, art. 4, 2018 O.J. (L 156) 32 (explaining that member states must limit their greenhouse gas emissions according to a linear trajectory that is five-twelfths of the distance from 2019 to 2020 or in 2020 according to what is lower). HANNES BÖTTCHER ET AL., EU LULUCF REGULATION EXPLAINED: SUMMARY OF CORE PROVISIONS AND EXPECTED EFFECTS 8 (2019)

carbon removals into its climate mitigation scheme reflects concerns about the uncertainty and impermanence of land-based carbon storage, as well as the potential for mitigation deterrence.[475]

2. Sectoral Targets

Distinct targets for carbon mitigation and carbon removal also should be set within specific sectors. Indeed, a 2021 National Academy of Sciences report recommends the establishment of a GHG emissions budget "that goes to net-zero in 2050 and that establishes separate sectoral benchmarks for net CO_2 emissions from all sectors (industry, buildings, transportation, electricity, agricultural operations, net emissions from bio-energy with carbon capture and sequestration, and negative emissions from direct air capture, mineralization, forestry and agricultural soils . . . .)"[476]

("For the first time, the LULUCF Regulation establishes a target for this sector in EU law. . . . The LULUCF Regulation introduces the obligation for Member States to ensure that emissions do not exceed removals from land use, land use-changes and forests.").

475 *See* Rickels, *supra* note 424, at 10 ("The reason for such likely exclusion relates to the often uncertain or impermanent storage of CO_2 that would make it hard to equate one ton of avoided fossil emissions with one ton of removed (biogenic) emissions.").

476 NAS, ACCELERATING, *supra* note 27, at 183.

Setting distinct targets for individual sectors of the economy can provide stronger incentives for actions that contribute to achieving net zero on a global scale.[477] Focusing on key GHG-emitting sectors and identifying concrete pathways for achieving net zero within each sector will reduce reliance on problematic assumptions about the feasibility of carbon removal strategies.[478] Unable to shift responsibility for reducing emissions or removing carbon to sources in other sectors, each sector will be encouraged to develop and implement techniques for reducing its own emissions or removing carbon.[479] The inability to access cheaper emissions reductions from a different sector does mean that a sector-based approach

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[477] *See* Noa Hoffman, *Exclusive: Government Set To Announce Ambitious Carbon Emission Reduction Target For Power Sector By 2035*, POLITICSHOME (Oct. 17, 2021), https://perma.cc/3K9D-GTVB; Kaya et al., *supra* note 460, at 1742–43.

[478] *See* Kaya et al., *supra* note 460, at 1740 (advocating shift from a global examination to a country-specific and sector-specific examination of how to achieve net zero in order to make the goal more manageable).

[479] *See* David Driesen, *Is Emissions Trading an Economic Incentive Program?: Replacing the Command and Control/Economic Incentive Dichotomy*, 55 WASH. & LEE L. REV. 289, 334 (1998).

could involve higher costs.[480] Sectoral targets nonetheless can ease individual company concerns that decarbonization efforts will put them at a competitive disadvantage.[481]

3. Policy Incentives

Even if governments set sectoral targets, they would also have to decide on policies to achieve those targets.[482] With respect to mitigation, policymakers have a wide range of tools to incentivize decarbonization and energy efficiency—mandates, taxes, subsidies, cap-and-trade systems, renewable portfolio standards, etc.[483] Policies could promote both mitigation and carbon removal. For example, emitters could be required to balance out their emissions by directly or indirectly removing an equal amount of carbon from the

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480 *See* WEF, *supra* note 66, at 18 ("In most sectors, full decarbonization would require implementing even costlier measures. Especially in hard-to-abate industry and transport sectors, moving to net-zero emissions will require the use of technologies that are not yet mature and are therefore very expensive.").

481 *See id.* at 33.

482 *See* Kaya et al., *supra* note 460, at 1740 (recommending continued policy maker involvement in encouraging continued research and development and updating roadmaps toward net zero emissions).

483 *See id.* at 1739 ("[I]n addition to economic incentives and other policy measures, [a policy guideline called 'Net Zero CO2 emissions without relying on massive CDR'] would help to overcome the often simplistic demands for positive modelling results and refocus climate policy on tackling the enormous barriers in key emitting sectors.").

atmosphere.[485] An emissions tax or liability regime could require emitters to pay for carbon removal.[486] And policies may focus specifically on incentivizing the development of specific types of carbon removal or ameliorating their adverse effects.[487]

Whether distinct targets should be set for different types of carbon removal technologies poses a more difficult question. The variability and projected changes in costs

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[485] *See* Myles R. Allen et al., *The Case for Mandatory Sequestration*, 2 NATURE GEOSCIENCE 813, 814 (2009) (suggesting that the sale and use of fossil carbon only be allowed if "an adequate fraction of its carbon content has been permanently sequestered," where adequate fraction is "the ratio between cumulative emissions from the time the policy is fully adopted to total outstanding allowable emissions at that time"); Tracy Hester, *Legal Pathways to Negative Emissions Technologies and Direct Air Capture of Greenhouse Gases*, 48 ENV'T. L. REP. 10413, 10431 (2018) (suggesting that regulators should consider allowing facilities to offset their CO_2 emissions in one location with their CO_2 removals in another area).

[486] *See* Sabine Fuss et al., *Moving Toward Net-Zero Emissions Requires New Alliances for Carbon Dioxide Removal*, 3 ONE EARTH 145, 148 (2020) (noting proposal to require emitters to pay for removal of the CO_2 they emit, in order to incentivize CDR deployment); M.J. MACE ET AL., *supra* note 62, at 31 (noting that there must be a framework of liability in place to provide for redress for any net reversal of storage).

[487] *See* Rickels, *supra* note 424, at 6 (suggesting the award of additional carbon credits for carbon removal or the imposition of a floor requiring use of a minimum amount of carbon credits derived from carbon removal).

and maturity among techniques has led to a suggestion to phase in these techniques, starting with less costly ones and then introducing others as further development lowers their costs.[488] Addressing the issue will require policy choices that account for each technology's prospects, potential significance, and risks.[489] In other words, governments might have to engage in the difficult task of picking technology winners.[490] Nonetheless, reasonable policies at this juncture should set an overall carbon removal target and actively support a range of carbon removal technologies.[491] Otherwise, the techniques that are presently the cheapest to deploy are likely to proliferate despite their limitations, and currently more expensive techniques may languish notwithstanding their greater long-term potential.[492] Policy support for a

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488 *See* Fuss, *supra* note 47, at 147.

489 *See* Sergey Paltsev, *Managing Uncertainty While Developing Long-Term Strategies for GHG Emission Mitigation*, WORLD RES. INST., https://perma.cc/89N2-4KZ2.

490 *See* Gary E. Marchant, *Sustainable Energy Technologies: Ten Lessons from the History of Technology Regulation*, 18 WIDENER L.J. 831, 836 (2009) (stating that it is very difficult to determine in advance which energy technologies will succeed).

491 *See* Paltsev, *supra* note 489 ("[U]ncertainty about future costs and technologies should discourage governments from trying to pick the 'winners'; instead, their policy and investment focus should be on targeting emissions reductions from any energy source.").

492 *See* Rickels et al., *supra* note 424, at 11 ("Fully integrating NETs into the EU ETS at this stage would be an incentive to prioritize the use of low-cost NETs . . . . This would not only come at the expense of conventional emission reductions but also impede NETs with higher investment costs . . . .").

diverse portfolio of carbon removal techniques partially postpones the need to pick winners until more information is available regarding their relative merits.[493] At the same time, offering stronger support for techniques that promise more permanent carbon removal appropriately recognizes their greater value in combating climate change.[494]

Targets alone will not suffice to yield carbon removal on a scale sufficient to achieve net zero.[495] Financial support for research and development, such as the $447 million earmarked for carbon removal research by the December 2020 economic stimulus package, is one important step.[496] The same legislation also created a task force to study the amount

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493 *See* Lin, *supra* note 43, at 571–72 (arguing that support for carbon removal research can facilitate learning and guide choices among carbon removal technologies).

494 *See* Joppa et al., *supra* note 104 (lamenting the lack of a consistent standard for monetarily accounting for the duration of carbon storage or the potential for premature release).

495 *See* ECIU, *supra* note 25, at 1 ("[A] target is just a target—without policies to cut emissions progressively towards that target, there is a substantial chance that it will not be achieved[.]").

496 *See* Bobby Magill, *Stimulus Law Program to Scrub Carbon From Air Draws Skeptics*, BLOOMBERG LAW (Dec. 29, 2020), https://perma.cc/4TVZ-LFFB (reporting on passage of stimulus bill designating $447 million for carbon removal). The research program aims "to test, validate, or improve technologies and strategies to remove carbon dioxide from the

of carbon removal needed to achieve net zero by 2050, evaluate different carbon removal approaches, and make policy recommendations.[497] Policies to encourage deployment of mature carbon removal technologies might include carbon credits or tax benefits for reforestation and agricultural practices that enhance soil carbon storage.[498] Policies to support engineered carbon removal might establish clear strategies that foster certainty for

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atmosphere on a large scale." Consolidated Appropriations Act 2021, H.R. 133, 116th Cong. § 969D(a) (enacted). The legislation defines carbon removal to include DACS, enhanced carbon mineralization, BECCS, forest restoration, soil carbon management, and direct ocean capture, § 5002(a), but singles out DACS for particular support through prize competitions and other means, § 5001.

[497] *See* Consolidated Appropriations Act 2021, H.R. 133, 116th Cong. § 5002 (enacted) (mandating a report no later than 180 days after the bill's enactment detailing estimates, inventory, and recommendations regarding a variety of issues pertaining to carbon removal).

[498] *See* ZCAP, *supra* note 90, at 119; Marc Heller, *Farmers Say They Can Do More on Climate—If Congress Helps*, FARMS.COM (Mar. 01, 2021), https://perma.cc/W7M2-7SRU (describing how farmers can use regenerative agriculture and conservation practices to cut down on greenhouse gas emissions, but will need congressional regulatory support to do so,).

developers and other actors, coordinate permitting processes, identify potential geological sites and corridors, and extend or expand existing tax credits.[499]

CONCLUSION

Achieving net zero on a global scale is essential if we are to flatten the curve on climate change. Net zero pledges by nations and corporations can play a pivotal role in the battle against climate change but must constitute more than vague promises. Concrete goals and deadlines can promote accountability, as can transparency on emissions, mitigation measures, and reliance on offsets and carbon removal. In setting net zero targets, entities should spell out emissions pathways leading to net zero, as pathway specifics directly shape the remaining carbon budget and the probability of achieving the Paris temperature goals. Interim targets can assist actors to develop and revise effective strategies for implementing net zero, build confidence among stakeholders regarding future conditions and expectations, and enable observers to understand target ambitions and assess performance.[500]

Enforcing private net zero targets is challenging because of their voluntary, aspirational, and long-term nature. Various mechanisms nonetheless can be brought to bear on companies to follow through on their net zero pledges. Such mechanisms include securities

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[499] *See* Elkind, *supra* note 49, at 10–21; Beuttler, *supra* note 405, at 6. And while high costs have limited CCS's role in mitigation efforts to date, net zero goals may ultimately require full carbon capture by facilities that burn fossil fuels and other major GHG emitters. Wendy B. Jacobs & Michael Craig, *Legal Pathways to Widespread Carbon Capture and Sequestration*, 47 ENV'T. L. REP. 11022, 11030–31 (2018).

[500] *See* NCI, NAVIGATING THE NUANCES, *supra* note 6, at 32.

fraud litigation, actions under consumer protection laws, contractual arrangements, and consumer and investor pressure. Many of these mechanisms are just beginning to be tested with respect to environmental sustainability claims. Enforcing net zero commitments by governments also is challenging, particularly for commitments not enshrined in law. Statutory, constitutional, or human rights litigation may nevertheless offer recourse in some countries, as a growing number of climate change-related decisions suggest.

The net zero concept assumes that residual carbon emissions will be counterbalanced by removal of carbon from the atmosphere. The rush to adopt net zero pledges should not obscure important differences between carbon removal and carbon mitigation with respect to verifiability, permanence, readiness, and risks. Distinguishing carbon mitigation and carbon removal in net zero goals is essential to avoid undermining efforts to achieve climate goals, shifting the burdens of climate action to vulnerable populations or future generations, and increasing societal, health, and environmental risks.